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MARYLAND

Agricultural Experiment Station.

BULLETIN NO. 51.

HORSE FEEDING.

Tests of the Digestibility of Oats, Corn, Hay and the New Corn Product.

College Park, Md.

December, 1897.

MARYLAND
Agricultural Experiment Station.

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HORSE FEEDING.

TESTS OF THE DIGESTIBILITY OF WHOLE AND GROUND OATS, SHELLED CORN AND CORN MEAL, TIMOTHY HAY AND THE NEW CORN PRODUCT: ALSO A TRIAL OF SOME RATIONS, USING THE NEW CORN PRODUCT AS A SUBSTITUTE FOR HAY.

By H. J. Patterson, B. S., Chemist.

Considering the important place which horses occupy among domestic animals, it is surprising that so little time, comparatively, has been given to a study of the character of food and manner of feeding best adapted to their needs under different conditions and according to the various demands made upon them.

There is more knowledge demanded upon the subject of feeding horses, not only because of their position, but also because of the great importance of knowing how to maintain them most economically. In horse feeding, as in many other things, it is necessary to keep pace with changing conditions and not practice the wasteful methods prevalent in times past, especially such waste as is commonly found among farmers. Again one sees the necessity for more knowledge along this line when proper consideration is given to the well recognized fact among veterinarians that improper feeding is responsible for most of the digestive disorders met with.

CONDITION IN HORSE FEEDING.

The state of perfection to which the higher class of horses has been brought in this country is attributed not only to the great attention devoted to the selection of the best types for the purpose of perpetuating the species, but also to the nature of the food with which they have been supplied and the treatment they have received, under the influence of a propitious climate.

Practical experience has assured us that the climate and atmosphere of this country are suitable to the constitutions of the equine tribe; but that the varying nature and at times great severity of the elements makes protection necessary in order to avoid their deleterious effects. For the best results, whether the horse be for ordinary farm

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work, for the cart, for the carriage, or for the race track, it is all important that their quarters should be warm, well ventilated, and supplied with pure and uncontaminated air. After furnishing these conditions the next great necessity is to carefully observe the food requirements and supply them.

OBJECTS IN HORSE FEEDING.

The objects sought in horse feeding are rather different from those desired in feeding any other class of domestic animals, and in consequence the points to be observed are, in a measure, peculiar. From the birth of a horse until arrival at an age for actual service the aim is to develop to the greatest degree the endurance and physical powers of the animal. These qualities depend upon the muscular fiber, sinews and bone. and they in turn are dependent upon the quality and quantity of food. After having grown and developed a horse with the desired qualities, the next consideration is to feed the animal in such a way that all the bodily functions may be supported, bodily wastes replaced, and the whole be maintained in its normal condition. If the animal is subjected to comparative rest there will be one kind of food required; if subjected to heavy work such as hauling loads slowly, there will be a food required to supply the energy as needed; or, so to speak, a food (fuel) of slow combustion; if the work is of a character that requires rapid action such as the trotting horse is subjected to, there will be demanded a food of a very different character from either of the former; or, so to speak, it will require a food (fuel), of rapid combustion.

In all horse feeding the aim is to maintain the force and endurance which the horse already possesses, and to develop these qualities when possible. When it is desired to have a horse increase in weight and size and take on a well-rounded appearance, it should be done by adding to his muscle rather than to increase greatly the amount of adipose substances. This kind of development can only be done comparatively slowly and when the animal is subject to such work as will develop muscle and keep down fat.

It is only the superficial judges of horses that are satisfied and pleased with the bones being covered, the points filled out, and general contour well-rounded; the person well versed in horses easily distinguishes between the appearance of a fat and of a muscular animal.

HORSE FOODS.

Every description of food contains nutritive properties, and abounds in a greater or less degree with the elements calculated for the construction of the different substances of which the animal body is composed. It is therefore important in selecting food for any class of animals, and for horses in particular, that those are obtained which contain the most of those compounds which are convertible into substances which render the animal of the highest value. The animal's growth and development of muscle, bone and sinew depend greatly upon the kind of food with which they have been supplied.

The subject of Horse Feeding can be conveniently divided into three parts: 1st, Water; 2nd, Grain Foods; 3rd, Long Foods, (hays or fodder).

Water:—Water for horses, as indeed water for all classes of domestic animals, should be free from organic matter or any contamination whatever. In fact it should be of just as good quality and as pure as required for man, and on no account should the idea be entertained that any water that stock can be persuaded to drink is of sufficient purity.

Horses should receive all the water they will drink, but in giving it to them due regard should be given to the condition of the animal at time of watering. Horses at rest should be watered three times a day, and when working should have small quantities frequently rather than allowed to drink much at one time. For the best results a horse should never be watered immediately before or after feeding.

Grain Foods:—Oats and corn are the principal grains used in horse feeding, and are generally recognized as the best ones; but rye, barley and wheat are considerably used, and the by-products, wheat, bran, linseed meal and gluten meal are used extensively as supplemental to the other grain rations.

Long or Bulky Food:—Timothy hay is almost universally considered as the best of the long foods for horses, yet many hays from mixed grasses are used, and is some sections alfalfa hay. In recent years in some sections cut and shredded corn fodder has become very popular, and for many years corn blades have been preferred, in the South, by the keepers of race horses.

Roots:—In some sections beets, carrots and potatoes are fed to horses in limited quantities for the purpose of improving the appetite and for the general beneficial action upon the digestive system. For this purpose they can be recommended, but they should never be fed in large quantities.

EXPERIMENTS CONDUCTED WITH HORSES.

The tests made in horse feeding, which form the basis for this bulletin, are as follows:

I. The determination of the digestibility of timothy hay by horses.

II. The determination of the digestibility of whole oats by horses.

III. The determination of the digestibility of ground oats by horses.

IV. The determination of the digestibility of shelled corn by horses.

V. The determination of the digestibility of corn meal by horses.

VI. The determination of the digestibility of the new corn product by horses.

VII. Tests of the use of the new corn product as a substitute for hay in horse feeding.

These experiments were undertaken with the object of acquiring some data of a more definite character than has been possessed before with reference to the comparative value of whole and ground grains, and also to determine whether the digestion coefficients of American feeding stuffs, which have been obtained in the most part with ruminants, are applicable to horses. Again, some phases of this question which are being discussed made it of interest to determine materials and the values of the same for use in horse feeding as a substitute for hay.

Horses are generally more unlike in their powers of digestion or in the uses they make of their food than a herd of cattle or a flock of sheep, largely due, no doubt, to the fact of the irregular and varying degrees of work to which horses are subjected. Then again, horses are generally worked to the full extent of their powers and at all ages so that individual weaknesses and feebleness in old age make themselves manifest. Consequently many difficulties are in the way of arriving at exact knowledge and fixed data which can be used as a universal guide.

METHODS AND APPARATUS USED.

The lengths of the periods in most cases were fourteen days, but in a few instances the tests were conducted for a longer time. The first nine days of each period were used as a preliminary period to allow any effects of previous feed to be overcome, and the digestion period covered five days.

During the digestion period the dung and urine were collected and samples drawn from each for analysis. The samples were drawn daily and dried to the air dry state. The sizes of the samples were in proportion to the total amount of excreta. Composite samples were made for each horse for each period.

The apparatus used in these tests was the same as used in the digestion experiments with steers, which is described and illustrated on page 167 of Bulletin No. 43, with a few modifications to adapt the trough and harness to the horses.

ANIMALS USED.

The animals used in the digestion experiments were two horses which were specially purchased for this work. They were of medium size, and while having some defects, yet had a good and normal digestion system. Horse No. 1, was four years old, weighed about 850 pounds and was sound with the exception of being blind in one eye. Horse No. 2, was nine years old, weighed about 950 pounds and had a defect in his wind which is known as a "Blower" or "Roarer."

FEEDS USED.

Oats:—The oats used were purchased in Baltimore, and were No. 1 white oats in quality. The ground oats used were from the same lot, and had been ground at the local mill.

Corn:—The corn used was raised on the Station Farm, and was of the Yellow Dent variety. The meal was from the same kind of shelled corn, and was ground by the local mill.

Hay:—The timothy hay used was raised on the Station farm. It was cut when in full bloom, nicely cured, and such hay as would generally pass as No. 1.

The New Corn Product:—The new corn product used is the same meterial as described on page 165 of Bulletin 43, and was made from fodder grown in the neighborhood of the Rockford Illinois factory.

The other feeds used in the feeding tests were hominy chop, linseed meal and King gluten meal, which were bought in the general markets and were of good quality and about average composition.

The composition of the feeds used are given in Table I, that of the dungs in Table II, and the nitrogen contents of the urine in Table III, which are as follows:

Table I.—Composition of Foods Used in Horse Feeding Experiments.

Index No.	Description of Sample.	Water	Ash.	Protein.	Crude fiber	N free extract	Fat.
		Per cent	Per cent	Per cent	Per cent	Per cent	Per cent
1992	Timothy hay........	11.41	4.57	4.45	33.20	42.99	3.38
2114	New corn product ..	8.51	5.41	6.56	27.30	49.30	2.92
1994	Oats—1st lot.... ..	8.56	3.68	12.42	11.91	56.53	6.90
2020	Oats—2d lot........	9.26	3.45	13.82	9.85	57.36	6.96
2000	Shelled corn........	22.22	1.33	8.53	1.72	62.27	3.93
2112	Corn meal...........	12.69	1.85	9.28	1.71	70.07	4.40
2049	Ground oats........	8.59	3.61	13.21	8.81	59.38	6.40
1996	Ground rye.........	16.09	1.98	11.76	2.49	65.17	2.51
1999	Hominy chop.......	17.63	2.69	9.57	4.43	55.38	10.30
1997	Linseed meal.......	10.00	4.38	37.36	8.98	31.70	7.60
1998	Gluten meal........	11.41	1.68	34.16	1.76	35.19	15.80
2001	Wheat bran	17.51	5.24	14.63	10.92	46.28	5.42
2121	Complete ration....	10.93	4.32	12.91	16.75	49.89	5.20

Table II.—Composition of Dungs from Horses on Digestion Experiments.

Index No.	Description of Sample.	Water.	Ash.	Protein.	Crude fiber.	N-free extract.	Fat.
		Per cent	Per cent	Per cent	Per cent	Per cent	Per cent
2031	Horse 1—Feed timothy hay only	76.08	1.44	1.75	8.87	11.00	0.86
2037	Horse 2—Feed timothy hay only	80.46	1.18	1.32	7.61	8.74	0.69
2023	Horse 2—Feed oats only	62.41	3.52	2.34	11.42	18.47	1.84
2007	Horse 1—Feed timothy hay and oats	71.39	2.71	2.07	9.35	12.97	1.51
2017	Horse 2—Feed timothy hay and oats	75.90	1.69	1.61	8.88	11.07	0.85
2046	Horse 1—Feed timothy hay and ground oats	72.74	2.20	2.20	9.99	11.74	1.13
2054	Horse 2—Feed timothy hay and ground oats.	76.92	1.57	1.82	8 67	10.07	0.95
2060	Horse 1—Feed timothy hay and shelled corn	71.73	1.65	2 43	10.77	11.84	1.58
2074	Horse 2—Feed timothy hay and shelled corn	75.66	1.37	2.79	8.19	10.67	1.32
2081	Horse 1—Feed timothy hay and corn meal	72.35	2.28	2.52	9.31	12.18	1.36
2087	Horse 2—Feed timothy hay and corn meal	80.12	1.32	2.10	7.26	8.18	1 02
2093	Horse 1—Feed N. C. Product and ground oats.	75.30	2.05	1.76	6.67	12.47	1.15
2099	Horse 2—Feed N. C. Product and ground oats	79.16	1.95	1.26	6.51	10.55	0.57
2105	Horse 1 — Feed Complete Ration—N. C. P. base.	73.73	2 98	2.11	8.38	11.68	1.12
2111	Horse 2 — Feed Complete Ration—N. C. P. base.	80.58	1.84	1.51	6.27	9.09	0.71

Table III.—Percentage of Nitrogen in Urine.

Index No.	Horse No.	Ration.	Nitrogen Per Cent.
2012	1	Whole oats and timothy hay	1.50
2018	2	“ “ “ “ “	1.53
2024	2	Oats only	2.01
2032	1	Timothy hay only	.77
2038	2	“ “ “	.78
2047	1	Ground oats and timothy hay	1.34
2055	2	“ “ “ “ “	1.33
2061	1	Shelled corn and timothy hay.	.88
2069	2	“ “ “ “ “	1.15
2082	1	Corn meal and timothy hay	1.22
2088	2	“ “ “ “ “	1.39
2 94	1	Ground oats and new corn product	1.24
2100	2	“ “ “ “ “ “	1.64
2106	1	Mixed ration N. C. P. base.	1.85
2112	2	“ “ “ “	1.94

I.—DETERMINATION OF THE DIGESTIBILITY OF TIMOTHY HAY.

Timothy hay is the standard coarse fodder, or long food, of the horse in most parts of the United States, and as a rule, where it can be had of good quality, in abundance and cheaply, there is little else to be desired in the way of hays for horses. The digestive coefficients of foods for the horse have in the most part been determined by German experiments conducted upon the kinds and qualities found in that country. The most prominent digestion experiments with the horse were those which were performed by Wolff, at Hohenheim, and the feeds used were chiefly oats and meadow hay. The results of these tests showed that horses did not possess as great digestive powers as ruminants, and in the case of hay the difference amounted to 11 or 12 per cent. of the dry substance. Nearly, if not all, the tests of the digestibility of timothy hay that are recorded have been made with ruminants; it, therefore, seemed desirable to obtain the coefficients with horses in order to determine the relative difference and have this data, which is so important a factor in the calculation of rations for horses.

During the digestion experiment with timothy hay the horses received nothing but hay and water, no grain whatever being allowed. The animals were fed regularly and given all they would eat. The amounts consumed were much less than expected, but the horses seemed satisfied, and ate the amounts indicated with a relish. The nutriment furnished by the quantity of hay was evidently sufficient for their wants as is evidenced by the weights. The weights in this and in all cases recorded in this bulletin were the average of two weighings. The weights were taken on Saturdays and Mondays, and the average considered to be the weight on the Sunday intervening.

The following table gives all the data with reference to the length of periods, quantity of food and water consumed and excreted, &c:

Table IV.—Ration, Timothy Hay Only.

		Horse No 1.	Horse No. 2.
Length of preliminary period		11 days.	11 days.
Length of digestion period		7 days.	5 days.
		Grams.	Grams.
Food consumed in preliminary period.	Timothy hay	54.660	55,560
	Water drunk	152 640	185,460
Food consumed in digestion period.	Timothy hay	36,000	30,000
	Water drunk	92,040	94.480
Excrement	Dung	69.640	82,580
	Urine	33,320	21.260
Weight of horses	At beginning of experiment.	857 lbs.	944 lbs.
	At end of experiment	857 "	946 "

Taking the data given in the above table and the composition of the food and excreta, the digestion coefficients indicated in Table V are obtained.

Table V.—Digestibility of the Components of Timothy by Horses.

Length of Digestion period: Horse No. 1—7 Days; Horse No. 2—5 Days.

(In Grams, 453.6 Grams = 1 Pound.)

	Fresh substance.	Dry substanee.	Ash.	Protein.	Crude fiber.	N-free extract.	Fat.
Horse 1.	Grams	Grams	Grams	Grams	Grams	Grams	Grams
Hay eaten (1992*)	36,000	31.895	1,645	1,602	11,955	15.476	1,217
Dung excreted (2031*)...	69,640	16,657	1,003	1.218	6,177	7.660	599
Digested......	. ....	15,238	642	384	5,778	7.816	618
Per cent. digested	....	47 77	39.03	23.97	48.34	50.51	50.78
Horse 2.							
Hay eaten (1992*).	30.000	26.577	1,371	1.335	9,960	12 897	1,014
Dung excreted (2037*)...	82,580	16,136	974	1,090	6,284	7,218	570
Digested...............	....	10,441	397	245	3,676	5.679	444
Per cent. digested.......	....	39.30	28.96	18.35	36.90	44.05	43.79
Average for 2 horses....	....	43.54	33.99	21.16	42.62	47.27	47.28
Pounds digestible in 100 lbs. of hay.	....	38.5	1.5	0.9	14.2	20.3	1.6

*These figures refer to index numbers in Tables I and II.

Giving a nutritive ratio of 1:42.3 for timothy hay.

Bringing the above results together with the average obtained with ruminants, we have the following:

Table VI.—Digestibility of Timothy Hay (Per cents.)

		Dry substance.	Ash.	Protein.	Crude fiber.	N-Free extract.	Ash.
By horses (average of 2 trials...		43.54	33.99	21.16	42 62	47.27	47.28
By ruminants (22 trials)...	Minimum.	47.0	.....	38.8	37.2	55.6	34.6
	Maximum.	65.7	.....	60.4	62.1	71.8	61.8
	Average..	53.0	.....	45.0	46.0	60.0	54.0

Using the above coefficients and the compositions of the hay used in this test and that of the average hay, and making the respective calculations, we obtain the amounts of available food constituents as shown in Table VII.

Table VII.—Quantity Digestible in 100 Pounds of Timothy Hay.

		Dry Substance.	Ash.	Protein.	Crude Fiber.	N-free Extract.	Fat.	Nutrition Ratio.
By horses.	Hay used in this experiment..	38.5	1.5	0.9	14.2	20.8	1.6	1:42.3
	Average Hay..	37.8	1.5	1.3	12.4	21.3	1.3	1:28.1
By Ruminants	Hay used in this experiment..	46.9	1.0	2.0	15.2	25.8	1.9	1:22.7
	Average hay..	46.1	...	2.6	13.2	27.0	1.3	1:16.6

These figures agree quite closely with those obtained in the Hohenheim tests as to the relative amounts of total dry substance digestible by horses and ruminants, but the differences in the quantities of digestible protein is considerably greater. This causes a wide range in the nutritive ratios.

It will be noticed that the coefficients of digestibility for the protein obtained in this test is relatively low, which may be attributed to the small quantity of food eaten and in consequence a relatively greater amount of metabolic nitrogenous elements in the excreta; though the weights of the animals would seem to indicate that there was a considerable loss in this way. Also careful examination could detect nothing of this nature.

Nitrogen determinations were made in the urine, which, on calculation, give the following figures, and show that though the weights of the animals seemed to indicate a state of equilibrium, the real condition was far from such:

	Quantity of Urine. Grams.	Per cent. Nitrogen.	Quantity of Nitrogen in Urine. Grams.	Quantity of Nitrogen Assimilated. Grams.	Difference. Grams.
Horse 1......	33,320	0.77	256.6	61.4	Loss..195.2
Horse 2.....	21,260	0.78	165.8	39.2	Loss..126.6

These figures would seem to prove that timothy hay was entirely inadequate for the maintenance of horses even at comparative rest, unless they could be persuaded to eat three or four times as much as was consumed in this test.

Should the weights of the horses be assumed to represent the truth, then there must have been a state of equilibrium between the nitrogen assimilated and the nitrogen excreted in the urine. Making calculations upon this assumption, we find that all the nitrogen fed would have been digested, which would evidently not represent the truth. The probable correctness of the coefficients as given in Table V, will become apparent on comparison with the figures given in Table XII, Page 23, when the manner in which they were obtained is considered.

II.—THE DIGESTIBILITY OF WHOLE OATS.

In making the determination of the digestibility of oats it was expected that the animals could be kept on a diet of the grain alone for a sufficient length of time for obtaining the necessary data; but this was found impracticable. At first the horses would eat a normal amount and seem to require nothing further, but before the evidence of hay had disappeared from the dung there would be a very manifest dissatisfaction with the ration, as shown first by eating at the stalls, then a loss of appetite and dislike for the grain and drinking very little water.

A summary of this attempt at confining the horses on a ration of nothing but grain is given in Table VIII.

Table VIII.—Ration, Oats Only.

		Horse No. 1.	Horse No. 2.
Length of preliminary period		4 days.	8 days.
Length of digestion period		0 days.	3 days.
		Grams.	Grams.
Food consumed in preliminary period.	Grain	......	47.340
	Water drunk	......	88,670
Food consumed in digestion period.	Grain	......	1,660
	Water drunk	......	10,140
Excrement	Dung	......	5.060
	Urine	......	10.390
Weights of horses	At beginning of experiment.	......	972 lbs.
	At end of experiment	......	944 "

Horse No. 1 commenced by eating 6000 grams per day, and by the end of the fourth day would not eat any, and would drink very little.

Horse No. 2 consumed 6750 grams per day, and commenced to eat less by the seventh day and gradually less until he would eat none by the tenth day.

The change of weight of course is probably largely due to the difference in the stomach contents. The results recorded agree clearly with those so frequently experienced in the Army when on expeditions into sections where it is impossible to get hay or carry it with them.

To test if the dung excreted was any index as to what was taking place, samples were taken and analyzed, but the results, on calculation as to the amount consumed during the time, showed no relation whatever between consumption and excretion, and were extremely negative.

In consequence of the above results we were forced to introduce hay into the ration, and to assume it to have the same digestitbility when fed in the combination as when fed alone, so that the coefficients for the timothy hay could be used as a constant factor. This assumption is not strictly correct—at least with certain food conponents, as will appear in subsequent discussions. The timothy hay used in this portion of the work, and in all other tests in this bulletin, was the same as used when hay was fed alone.

It was the aim and desire to have the horses eat the same quantity of hay at all times, but their appetites did not demand it, and the quantities had to be varied accordingly.

In feeding, the grain was divided into three feeds, (morning, noon and night) and the hay given only at the morning and night feeds. The hay was cut so as to be two or three inches long in order to facilitate feeding and prevent loss.

The details of consumption, excretions, weights, &c., are as follows:

Table IX.—Ration, Timothy Hay and Whole Oats.

		Horse No. 1.	Horse No. 2
Length of preliminary period		8 days.	14 days.
Length of digestion period		5 days.	5 days.
		Grams.	Grams.
Food consumed in preliminary period.	Timothy hay	20,176	54,790
	Grain	48.000	84,000
	Water drunk	108.350	306,020
Food consumed in digestion period.	Timothy hay	10,930	16,390
	Grain	30.000	30,000
	Water drunk	61.520	91,980
Excrement	Dung	39.500	73,570
	Urine	22,630	24,480
Weight of horses	At beginning of experiment.	852 lbs.	973 lbs
	At end of experiment	860 "	972 "

From this data and the composition of the feeds and dungs and making deductions for the hay, we obtain Table X.

Table X.—Digestibility of Whole Oats by Horses.

Rations Fed—Timothy Hay and Whole Oats. (Length of Digestion Period—5 Days.

	Fresh substance.	Dry substance.	Ash.	Protein.	Crude fiber.	N-free extract.	Fat.
Horse 1.	Grams	Gram	Grams	Grams	Grams	Grams	Grams
Hay eaten (1992).........	10,930	9,682	499	486	3,629	4,699	369
Grain eaten (1994).......	30,000	27,432	1,104	3,726	3,573	16,959	2,070
Total eaten..............	40,930	37,114	1,603	4,212	7.202	21,658	2,439
Dung excreted (2007)....	39.500	11,304	1,070	818	3,696	5,124	596
Total digested	....	25.810	533	3,394	3.506	16,534	1,843
Digested from hay......	....	4.625	195	116	1,755	2,373	187
Digested from grain.....	....	21,185	338	3,278	1,751	14,161	1,650
Per cent. digested from grain.................	....	77.24	30.61	87.98	49.01	83.52	80.00
Horse 2.							
Hay eaten (1992)	16,390	14,520	729	729	5 442	7,046	554
Grain eaten (1994).......	30,000	27,432	1,104	3,726	3,573	16,959	2,070
Total eaten.......	46,390	41,952	1,853	4,455	9.015	24,005	2,624
Dung excreted (2017)....	73,570	17,728	1,243	1,184	6,532	8,144	625
Total digested....	....	24,224	610	3,271	2 483	15 861	1,999
Digested from hay......	....	5,707	217	133	2,009	3 104	243
Digested from grain.....	....	18,517	393	3,138	474	12,757	1,756
Per cent. digested from grain	....	67.51	35.60	84.22	13.26	75.23	84.83
Average for two horses..	....	72.38	33.10	86.10	31.14	79.38	82.42
Pounds digestible in 100 lbs. of oats............	....	66.2	1.2	10.7	3.9	44.8	5.6

Giving a nutritive ratio of 1:5.73 for whole oats.

The nitrogen excretion and consumption is shown by the following figures (Table XI). It will be seen that there was considerably more nitrogen assimilated than excreted, and on examining the weights we see that they remain practically constant, from which it may be concluded that the food consumed was sufficient to support all bodily functions.

Table XI.—Showing Distribution of Nitrogen During Digestion Test.

	Quantity of Urine Excreted.	Per cent. Nitrogen.	Quantity of Nitrogen Excreted.	Quantity of Nitrogen Assimilated.	Difference.
Horse No. 1......	22,630	1.50	353 8	543.0	Gain..190 8
Horse No. 2......	24,480	1.53	374.5	523.4	Gain 148.9

Bringing the coefficients obtained above into one place with those obtained for oats by Wolff in the Hohenheim experiments, we have the following:

Table XII.—Per Cents. Digestible.

	Dry substance.	Protein.	Crude fiber.	N-free extract.	Fat.
Oats—this experiment..	72.4	86.1	31.1	79.4	82.4
Oats—Wolff............	....	87.0	26.0	77.0	78.0

The results of these two experiments show a remarkable agreement, and would give strong indication (considering the fact that the hay coefficients were used as a constant and deducted in determining those of oats) that the digestion coefficients for hay were nearly correct.

III.—THE DIGESTIBILITY OF GROUND OATS BY HORSES.

There is considerable diversity of opinion as to the relative value of whole, bruised, crushed and ground oats for horses, and as to their digestibility by horses of different ages. To get some data on these points it was decided to make the test with ground oats rather than any of the intermediate stages. Spooner gives as his opinion that horses do not eat bruised and crushed oats with an appetite, and that oats in this condition are apt to cause diarrhoea in horses which are worked hard. Experiments with whole and ground grain for work horses at the Utah Station showed no advantage of one over the other.

The oats used were of the same quality as fed whole, but had been ground.

The horses were fed, at first, the same relative quantities of hay and grain as used in the periods when on hay and whole oats, but it was soon found that they would not eat nearly as much grain and would take more hay, consequently it was deemed better to feed all of each kind of food that would be consumed rather than limit the quantity of hay and introduce the error which might be caused by a dissatisfied appetite.

The following are the details of the feeding, &c.:

Table XIII.—Rations, Timothy Hay and Ground Oats.

		Horse No. 1.	Horse No. 2
Length of preliminary period		9 days.	9 days.
Length of digestion period		5 days.	5 days.
		Grams.	Grams.
Food consumed in preliminary period.	Timothy hay	31,510	36,000
	Grain	28.670	37,500
	Water drunk	99,800	146,970
Food consumed in digestion period.	Timothy hay	20,000	20.000
	Grain	14,800	15,500
	Water drunk	71,220	82,220
Excrement	Dung	47,280	59.660
	Urine	15,880	19,420
Weights of horses	At beginning of experiment.	856 lbs.	946 lbs.
	At end of experiment	856 "	951 "

Making similar calculations and deductions for the hay as in obtaining the coefficients for whole oats, we have the figures in Table XIV for ground oats.

Table XIV.—Digestibility of Ground Oats by Horses.

Rations Fed—Timothy Hay and Ground Oats. (Length of Digestion Period—5 Days.)

	Fresh substance.	Dry substance.	Ash.	Protein.	Crude fiber.	N-free extract.	Fat.
	Grams	Grams	Grams	Grams	Grams	Grams	Grams
Horse 1.							
Hay eaten (1992).........	20,000	17,781	914	890	6,640	8,598	676
Grain eaten (2040)........	14,800	13,528	534	1,955	1,304	8,788	947
Total eaten..............	34,800	31,246	1,448	2 845	7,944	17,386	1,623
Dung Excreted (2046)....	47,280	12,890	1,040	940	4,726	5,550	534
Total digested..	... ...	18,356	408	1,805	3,218	11,836	1,089
Digested from hay	....	8,495	357	213	3,210	4,345	343
Digested from grain.....	....	9,861	51	1,592	8	7,491	746
Per cent. digested from grain	....	72.91	9.55	81.44	0.61	85.23	78.77
Horse 2.							
Hay eaten (1902).........	20,000	1,7781	914	890	6,640	8,598	676
Grain eaten (2049).......	15,500	14,170	561	2,047	1,366	9,204	992
Total eaten......... ...	35,500	31,688	1,475	2,937	8,006	17,802	1,668
Dung excreted (2054)....	59,660	13 770	936	1,086	5,172	6,009	567
Total digested	....	18,118	539	1,871	2,834	11,793	1,101
Digested from hay	....	6,988	265	163	2,450	3,785	297
Digested from grain.....	....	11,130	274	1,708	384	8,008	804
Per cent. digested from grain..................	....	78.55	48.85	83.44	28.11	87.00	81.04
Average for 2 horses		75.73	29.20	82.44	14.36	86.12	79.90
Pounds digestible in 100 lbs. of ground oats....	....	69 3	1.0	10.9	1.2	51.1	5.1

Giving a nutritive ratio of 1:5.84 for ground oats.

Bringing the results for whole and ground oats together for comparison, we have the following:

Table XV.—Digestion Coefficients and Quantities Digestible in 100 Pounds of Whole and Ground Oats.

	Dry substance.	Ash.	Protein.	Crude Fiber.	N-free extract.	Fat.	Nutritive ratio.
	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent
Whole oats......	72.4	33.1	86.1	31.1	79.4	82.4	....
Ground oats	75.7	29.2	82.4	14.4	86.1	79.9	....
Quantity available in 100 pounds of:	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
Whole oats.......	66.2	1.2	10.7	3 9	44.8	3.6	1:5.73
Ground oats......	69.3	1.0	10.9	1.2	51.1	5.1	1:5.84

The average results are slightly in favor of the ground oats. An examination of the results with the young horse (No. 1) and the old horse (No. 2,) shows that the whole oats were more digestible by the young horse and the ground oats by the old horse. From this we would conclude that, other things being equal as to appetite, ability to perform work, &c., with a lot of horses of varying ages, the most can be obtained from oats by feeding it ground.

IV.—A COMPARISON OF THE DIGESTIBILITY OF SHELLED CORN AND CORN MEAL (GRAIN OR MAIZE).

In this portion of the work the same kind of timothy hay was fed in conjunction with the grain as was used in the tests already described, and hence the same constant factor introduced.

It was recognized in planning these experiments that whole corn was, as a rule, fed on the cob rather than shelled; but from the fact that many horses will at times eat a portion of the cob, it was deemed best to have the corn shelled, and so eliminate the error which would be introduced by the consumption of a variable quantity of cob. As already described, the corn meal was from the same kind of corn as that fed whole.

In these tests, as in those with oats, it was not possible to have the same relative consumption of grain and hay at all times, yet the agreement is much closer than in the oats periods.

The details of the feeding periods are given by the following tables XVI and XVII:

Table XVI.—Ration, Timothy Hay and Shelled Corn.

		Horse No. 1.	Horse No. 2.
Length of preliminary period		9 days.	9 days.
Length of digestion period		5 days.	5 days.
		Grams.	Grams.
Food consumed in preliminary period.	Timothy hay	32,010	31,120
	Grain	20,750	31,500
	Water drunk	86,300	125,320
Food consumed in digestion period	Timothy hay	15,000	15,000
	Grain	15.000	15.000
	Water drunk	40.350	57,640
Excrement	Dung	33.560	47.130
	Urine	15.050	9.890
Weight of horses	At beginning of experiment.	856 lbs.	951 lbs.
	At end of experiment	842 "	957 "

Table XVII.—Ration, Timothy Hay and Corn Meal.

		Horse No. 1.	Horse No. 2.
Length of preliminary period		9 days.	9 days.
Length of digestion period		5 days.	5 days.
		Grams.	Grams.
Food consumed in preliminary period.	Timothy hay	27,000	27,000
	Grain	24,120	35,000
	Water drunk	85,150	109,910
Food consumed in digestive period.	Timothy hay	15.000	15,000
	Grain	14,350	17,500
	Water drunk	43,640	66,590
Excrement	Dung	32,140	46,090
	Urine	6,780	13,910
Weight of horses	At beginning of experiment.	842 lbs.	935 lbs.
	At end of experiment	832 "	935 "

From these, with the data furnished by Tables I and II, we calculate the result as given in Tables XVIII and XIX.

Table XVIII.—Digestibility of Shelled Corn by Horses.

Rations Fed—Timothy Hay and Shelled Corn. (Length of Digestion Period—5 Days.)

	Fresh substance.	Dry substance.	Ash.	Protein.	Crude fiber.	N-free extract.	Fat.
Horse 1.	Grams	Grams	Grams	Grams	Grams	Grams	Grams
Hay eaten (1992).........	15,000	13,287	685	667	4,980	6,448	507
Grain eaten (2000).......	15,000	11,667	200	1,279	258	9,340	590
Total eaten..............	30,000	24,954	885	1.946	5,238	15,788	1,097
Dung excreted (2060)....	33,560	9.490	554	816	3,614	3,976	530
Total digested...........	....	15,464	331	1,130	1,624	11,812	567
Digested from hay......	....	6,354	267	160	2,407	3,258	257
Digested from grain.....	....	9,110	64	970	....	8,554	310
Per cent. digested from grain..................	......	78.08	32.00	75.84	....	91.57	52.54
Horse 2.							
Hay eaten (1992).........	15,000	13,287	685	667	4,980	6.448	507
Grain eaten (2000).	15,000	11,667	200	1,279	258	9,340	590
Total eaten	30,000	24,954	885	1,946	5,238	15,788	1,097
Dung excreted (2074)....	47,130	11,471	646	1,315	3,860	5,028	622
Total digested	....	13,483	239	631	1,378	10,760	475
Digested from hay.......	....	5 222	198	122	1,837	2,838	222
Digested from grain.....	....	8,261	41	509	....	7,922	253
Per cent. digested from grain..................	....	70.81	20.50	39.80	....	84.82	42.88
Average for 2 horses	....	74.44	26.25	57.82	....	88.19	47.71
Pounds digestible in 100 lbs. of shelled corn....	....	57.9	0.3	4.9	(-4.9)	54.9	1.9

Giving a nutritive ratio of 1:10.6.

Table XIX.—Digestibility of Corn Meal by Horses.

Rations Fed—Timothy Hay and Corn Meal. (Length of Digestion Period—5 Days.)

	Fresh substance.	Dry substance.	Ash.	Protein.	Crude fiber.	N-free extract.	Fat.
Horse 1.	Grams	Grams	Grams	Grams	Grams	Grams	Grams
Hay eaten (1992).........	15,000	13,287	685	667	4,980	6,448	507
Grain eaten (2113)	14,350	12,529	265	1,332	245	10,056	631
Total eaten..............	29,350	25,816	950	1,999	5,225	16 504	1,138
Dung excreted (2081)	32,190	8,900	734	811	2,997	3 920	433
Total digested...........	....	16 916	216	1,188	2,228	12,584	700
Digested from hay......	....	6,354	267	160	2,407	3,258	257
Digested from grain.....	....	10,562	....	1,028	....	9,326	443
Per cent. digested from grain..................	....	83.96	....	77.18	....	92.74	70.21
Horse 2.							
Hay eaten (1992)	15,000	13.287	685	667	4,980	6,448	507
Grain eaten (2113).........	17,500	15,280	324	1,624	299	12,263	770
Total eaten..............	32,500	28,567	1,009	2,291	5,279	18,711	1,277
Dung excreted (2087)	46,090	9,162	608	968	3,346	3,770	470
Total digested...........	....	19,405	401	1,323	1,933	14,941	807
Digested from hay.......	....	5,222	198	122	1,837	2,838	222
Digested from grain.....	....	14,183	203	1,201	96	12,103	585
Per cent. digested from grain.........	....	92.82	62.66	73.95	32.72	98.70	75.99
Average for 2 horses....	....	88.39	....	75.57	....	95.72	73.10
Pounds digestible in 100 lbs. of corn meal	....	77.2	....	7.0	....	67.0	3.2

Giving a nutritive ratio of 1:10.6.

Bringing the results as given above together to facilitate comparison, Table XX is obtained.

Table XX.—Summary of Results of Digestion Tests With Shelled Corn and Corn Meal.

	Dry substance.	Ash.	Protein.	Crude fiber.	N-free extract.	Fat.	Nutritive ratio.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Digestion co-efficients....	....	....	....	....	....	....	....
Shelled corn (average) ..	74.4	26.3	57.8	....	88.2	47.7	....
Corn meal (average).....	88.4	....	75.6	....	95.7	73.1	....
Young horse (No. 1.) Shelled corn....	78.1	32.0	75.8	....	91.6	52.5	....
Young horse (No. 1.) Corn meal......	84.0	....	77.2	....	92.7	70.2	....
Old horse (No. 2.) Shelled corn....	70.8	20.5	39.8	....	84.8	42.9	....
Old horse (No. 2.) Corn meal......	92.8	62.6	74.0	32.1	98.7	76.0	....
Quantity available in 100 lbs. of:	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
Shelled corn.............	57.9	0.3	4.9	....	54.9	1.9	1:12.1
Corn meal...............	77.2	....	7.0	....	67.0	3.2	1:10.6

All the figures in the above tables show a decided advantage in favor of the corn meal over shelled corn. The horses had a better appetite when fed the meal, and digested considerably more. Especially is this true with the older horse.

In the above tables will be noted that in most instances there has apparently been no crude fiber digested in the grain; in fact, not enough digested to meet the calculated requirements of hay. These results agree with those of Wolff and Kreuzhage (Landus Johrb. Vol. 24, 1895, pp. 125-271) and are to the effect that concentrated foods often decrease the digestibility of the crude fiber in the hay. In this experiment there was actual digestion of the crude fiber in the total ration, but a very evident decrease in the digestible fiber in the hay. This seems greater than would ordinarily be indicated, owing to the relatively small amount of fiber in corn and the large amount of the other carbo-hydrates. A calculation of the amount of digestible fiber in the rations gave 28.7 per cent. for the shelled corn period and 39.6 per cent. for the corn meal period.

A comparison of the coefficients obtained for oats and corn shows the protein and fat of the oats to be more easily and apparently better digested than in corn, while the total digestible matter and digestible nitrogen free extract matter to be greater in corn than in oats.

The following table gives the relation between the nitrogen assimilated and excreted, but the results do not in all cases correspond to the weights of the animals:

Table XXI.—Showing Nitrogen, Assimilation and Excretion.

	Quantity of Urine. Grams.	Per cent. Nitrogen.	Quantity of Nitrogen in Urine. Grams.	Quantity of Nitrogen Assimilated. Grams.	Difference. Grams.
		In Shelled Corn Ration.			
Horse 1...	15,050	0.88	132.4	180.8	Gain.. 48.4
Horse 2.....	9,890	1.15	113.7	101.0	Loss.. 12.7
		In Corn Meal Ration.			
Horse 1.....	6,780	1.22	82.7	190.1	Gain..107.4
Horse 2.....	13,910	1.39	193.3	211.7	Gain.. 8.4

In the following table is given the digestion coefficients obtained for corn with horses and ruminants both in America and Germany; from which it will be seen that the variations with the two classes of animals is not so great as in the case of oats. The results in this average a little lower than those of the German experimenters, but the difference is not much.

Table XXII.—Comparison of the Digestibility of Corn by Horses and Ruminants.

	Dry substance.	Protein.	Crude fiber.	N-free extract.	Fat.
Corn meal—Horses	88.4	75.6	.....	98.7	73.1
Corn meal—Ruminants ..	88.0	60.0	.....	93.0	92.0
Shelled corn—Horses ...	74.4	57.8	.....	88.2	47.7
Corn by pigs—Wolff......	....	85.0	34.0	94.0	76.0
	....	78.0	100.0	94.0	63.0

V.—THE DIGESTIBILITY OF THE NEW CORN PRODUCT BY HORSES.

The new corn product is corn fodder from which the pith has been removed, and it may include the husks and blades, but generally not. In the process of separation the stalks are cut in small pieces and the pith removed, after which the balance is ground into a coarse meal, which in general appearance resembles coarse bran or dried brewer's grains.

The new corn product is subject to about the same variations in quality and composition as corn fodder generally, owing to differences in the quality of the material which is used in its manufacture and the thoroughness with which the pith is removed.

The following table will give some idea of the quality of the different samples which have been used at this Station:

Table XXIII.—Composition of New Corn Product.

Description of Sample.	Water.	Ash.	Protein.	Crude fiber.	N-free extract	Fat.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Material used in digestion experiments, steers (Bulletin 43)	9.22	4.00	6.38	28.70	48.86	2.84
Sample from carload from Owensboro, Ky., factory.	8.45	2.98	4.20	36.30	45.91	2.16
Sample from carload from Owensboro, Ky., factory.	6 42	2.96	4.38	36.66	47.12	2.96
Material used in digestion experiments with horses.	8.51	5.41	6.56	27.30	49.30	2.92
Sample from carload from Rockford, Ill., factory...	11.60	5.13	4.38	30.70	45.95	2.24

In the digestion experiment the ration fed was ground oats and the new corn product. The aim in starting out was to have the horses eat these in the same proportion as hay and ground oats had been consumed in a previous test, but they would not eat as much of the corn product as hay. The ground oats and corn product were mixed and wet with water, and fed as mixed feed. In feeding the new corn product it is always best to wet it to prevent the animals from blowing it out of the trough, and also to make it more palatable.

The following table gives the details of the materials consumed and excreted:

Table XXIV.—Ration, New Corn Product and Ground Oats.

		Horse No 1.	Horse No. 2.
Length of preliminary period		9 days.	9 days.
Length of digestion period		5 days.	5 days.
		Grams.	Grams.
Food consumed in preliminary period.	New corn product	21,750	29.250
	Grain	21,000	29 250
	Water drunk	40,999	82.410
	Water in mixed feed	40,620	53,590
Food consumed in digestion period.	New corn product	14.750	16 750
	Grain	14,750	16,750
	Water drunk	41,810	40.880
	Water in mixed feed	24,910	33,500
Excrement	Dung	37.020	59,580
	Urine	12,075	16,520
Weight of horses	At beginning of experiment.	832 lbs.	935 lbs.
	At end of experiment	833 "	940 "

Taking the data in the above table and the composition of the feeds and excreta and making the necessary calculations, the results as given in Table XXV are obtained:

Table XXV.—Digestibility of the New Corn Product by Horses.

Rations Fed—The New Corn Product and Ground Oats. (Length of Digestion Period—5 Days.)

	Fresh substance.	Dry substance.	Ash.	Protein.	Crude fiber.	N-free extract.	Fat.
Horse 1.	Grams	Grams	Grams	Grams	Grams	Grams	Grams
N. c. p. eaten (2114).....	14,750	13,496	798	968	4.027	7.272	431
Grain eaten (2049)........	14 750	13,484	533	1,949	1.299	8,759	944
Total eaten..............	29,500	26,980	1,331	2,917	5.326	16,031	1,375
Dung excreted (2093)....	37 020	9,144	981	652	2,469	4,616	426
Total digested..........	......	17,836	350	2,265	2,857	11,415	949
Digested from oats......	....	9,830	51	1,587	8	7,462	744
Digested from n. c. p.....	......	8,006	299	678	2,849	3,853	205
Per cent. digested from n. c. p............ ...	....	59.32	37.47	70.04	70.75	54.37	47.56
Horse 2.							
N. c. p. eaten............	16,750	15,325	906	1,099	4 574	8.257	489
Grain eaten.............	16,750	15,312	605	2 213	1,476	9,946	1,072
Total eaten..............	33,500	30 637	1,511	3,312	6,050	18,203	1,561
Dung excreted...........	59,580	12,418	1,162	751	3,879	6.286	340
Total digested..........	....	18,219	349	2,561	2,171	11,917	1,221
Digested from oats......	....	12,028	295	1,846	415	8,653	869
Digested from n. c p.....	....	6,191	54	715	1,756	3,264	352
Per cent. digested from n. c. p................	....	40 40	5.96	65.05	38.39	39.53	72 00
Average for 2 horses....	..... .	49.86	21.72	67.54	54.57	46.95	59.78
Pounds digestible in 100 lbs. of the new corn product............ ..	....	45.6	1.3	4.4	14.9	23 2	1.8

Giving a nutritive ratio of 1:9.57 for the new corn product.

Bringing the figures obtained for timothy hay together with those given above, we have the following:

Table XXVI.—Per Cents Digestible

	Dry sustance.	Ash.	Protein.	Crude fiber.	N-free extract.	Fat.
Timothy hay.......	45.5	34.0	21.2	42.6	47.3	47.3
New corn product..	49.9	21.7	67.5	54.6	47.0	59.8

Calculating from these digestion coefficients and the composition of the foods, the following are obtained as the amounts of the several ingredients which can be gotten by the horse from one hundred pounds of the respective foods:

Table XXVII.—Pounds Digestible Matter in 100 Pounds.

	Dry substance or Total Digestible matter.	Ash.	Protein.	Crude fiber.	N-free extract.	Fat.
Timothy hay........	38.6	1.5	0.9	14.1	20.4	1.6
New corn product...	45.6	1.3	4.4	14.9	23.2	1.8

From these figures it will be seen: 1st, that in one hundred pounds of the new corn product there was seven pounds more matter digestible than in one hundred pounds of timothy hay; 2nd, that the new corn product showed nearly five times as much protein digested by the horse as timothy hay; 3rd, that there was but a small difference in the digestibility of the crude fiber, nitrogen free extract and fat, but the difference was slightly in favor of the new corn product.

Comparison of the digestibility of the new corn product by horses and ruminants is given by the following figures:

Table XXVIII.—Comparative Digestibility by Horses and Ruminants.

	Dry substance.	Ash.	Protein.	Crude fiber.	N-free extract.	Fat.	Nutritive ratio.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	
By horses........	49.9	21.7	67.5	54.6	47.0	59.8	
By steers........	63.5	48.7	59.7	60.5	65.8	82.8	
Pounds in 100 lbs.	Lbs	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	
By horses	45.6	1.3	4.4	14.9	23.2	1.8	1:9.6
By steers........	57.6	1.0	3.8	27.3	32.2	2.4	1:14.4

From which it will be seen that the difference in digestibility by the two classes of animals is about the same relatively, as excreted in the case of hay, and that with horses showed, as a whole, a poorer digestion than steers, yet the protein was digested a little better by the horse.

The form in which the new corn product comes upon the market makes it adapted for horse feeding in many places where it is now impossible to get and feed hay, or inconvenient to carry. Again, if this product proves to be well adapted for horses under all conditions, its form will make it possible to feed a complete and well balanced ration with about half the labor ordinarily required.

Numerous efforts have been made to obtain a condensed ration for army uses, but in most part they have been forced to be confined to the grain only; but these failed because of the lack of hay or something to take its place. Nevertheless the test made by both the Swiss and Italian Armies showed compress grain to have the advantage of keeping longer, requiring less space, of being able to be pressed into uniform rations which makes the task of distribution and feeding easy.

The condition of the new corn product is such that it can be uniformly mixed with the ground grains, and it is superior to the grain in keeping quality, and its use would permit of compounding and compressing uniform rations for army purposes. This sort of ration would overcome the difficulties which officers now experience when in districts where hay cannot be procured, or when on forced marches. Also, such a ration could be fed from a nose bag.

VI.—MIXED FEEDS FOR HORSES.

Taking it literally, the term "mixed feed" would mean a combination of two or more foods, no matter whether it be two or more grains, hays, or grains and hays; but technically speaking, the term "mixed feed" means a mixing of the grain and hay through the aid of water so that the whole presents a uniform appearance and is in a form which must be eaten as though it was but a single substance. This is the common practice of the English farmer in feeding both horses and cattle, and the great economy of the system of cutting the fodder for horses and mixing the ground grain with it has been so well recognized for so many years that this has become the basis of the system in operation for feeding large numbers of horses on stage and car lines, and of cab horses both in this country and in Europe. As relating to the practical side of this question, consider the following, as given on page 377 of "Feeding Animals" by E. W. Stewart:

> "We shall now consider the practical rations established in this country, as applied to large numbers of horses devoted to special work. The establishment of street railroads in cities has given steady and exacting employment to many thousands of horses. The cost of feeding so many animals has been the large item which has called for careful study to determine the most economical ration consistent with highest efficiency of service. Many experiments were made with various kinds of grain, and various methods of preparing the ration. Hay was fed long, and the grain, ground or whole, fed alone; but it was soon found that much more long hay was required than when cut into short lengths, and the ground grain fed upon the hay. Their experience was similar to that of the London Omnibus Company, many years ago. This company had 6,000 horses, and determined to test the relative value of cut and uncut hay, as well as ground and unground grain. To this end 3,000 horses were fed ground oats, cut hay, and straw; and 3,000 were fed upon uncut hay and unground oats. The allowance to

the first was—ground oats, 16 lbs.; cut hay, 7½ lbs.; cut straw, 2½ lbs.; To the second was allowed—unground oats, 19 lbs.; uncut hay, 13 lbs. The horses which had 26 lbs. of ground oats, cut straw and hay, did the same work as well, and kept in as good condition as those that had 32 lbs. of unground oats and uncut hay. * * * The result of a ration applied to 3,000 horses must be accepted as an unquestionable fact."

Again, in speaking of corn as a food for horses, Stewart says:

"But as the object of grinding is to reduce the grain to such fine particles that the digesting fluid may saturate and completely act upon it in the shortest time, the value of grinding is in proportion to the fineness of division. And when this finely-ground corn-meal is mixed with a little more than half its weight, but several times its bulk, of cut hay, as above described, this fibrous hay so completely separates the particles of meal as to form a spongy, porous mass, that fluids will pass through freely."

"Indian corn is the great food crop for animals in this country, and is produced in nearly every county of every State, and probably more cases of horse cholic arise from feeding corn-meal than from all other food combined; and this especially occurs among farm horses, because farmers study the philosophy of foods very little, or the effect of condition in foods upon animal health. They feed what is most convenient and cheapest without considering that any good food can be other than healthy. We have known of the death of at least a dozen horses which, on examination, proved to be caused by feeding corn-meal alone. Some feed wet and others dry. But, when fed alone, it is more dangerous wet than dry, because the wet meal may be swallowed with very little mastication, while the dry meal must be masticated till the saliva saturates it before it can be swallowed, and the saliva assists digestion. It is, therefore, in better condition for digestion when fed dry than wet. But four of those who had lost horses by feeding meal alone, when they changed the system and fed the meal upon cut hay, moistened, so that both must be eaten together, had no further losses or even illness of their horses."

Considering these figures and the fact that farmers now have facilities for grinding and cutting feeds, it should become the common practice to feed "mixed feed." The new corn product is in a shape well adapted for making a "mixed feed," and still farther, it is in such a form that it may be made up with grains into a uniform mixture, and consequently large quantities can be mixed at once, which would reduce the labor of making a "mixed feed" at feeding time, to a minimum. In order to test the efficiency of such a composition of horse rations, and to test still further if American digestion coefficients obtained in most part with ruminants will hold out in practice when applied to horses, the following ration was made up with the new corn product as a base and replacing hay:

New corn product	50	parts.
Hominy chop	10	"
Ground oats	10	"
Ground rye	10	"
Linseed meal	10	"
Gluten meal	5	"
Wheat bran	5	"
Total	100	"

The amount of food consumed and the quantity of excreta during this period is given in Table XXIX.

Table XXIX.—Ration, Complete and Well Balanced Ration With New Corn Product Base.

		Horse No. 1.	Horse No. 2.
Length of preliminary period		9 days.	9 days.
Length of digestion period		5 days.	5 days.
		Grams.	Grams.
Food consumed in preliminary period.	Grain	51,500	62,000
	Water drunk	57,020	161.990
	Water in mixed feed	50,800	62,000
Food consumed in digestion period.	Grain	30.000	37,500
	Water drunk	40,330	47,180
	Water in mixed feed	30,000	37,500
Excrement	Dung	36,800	66,500
	Urine	12,760	19.270
Weight of horses	At beginning of experiment.	833 lbs.	940 lbs.
	At end of experiment	860 "	960 "

From which, by means of the composition of the ration, the digestibility, as given in Table XXX is calculated.

Table XXX.—Digestibility of the Components of a Complete Ration with the New Corn Product Base, by Horses.

(Length of Digestion Period—5 Days.)

	Fresh substance.	Dry substance.	Ash.	Protein.	Crude fiber.	N-free extract.	Fat.
Horse 1.	Grams	Grams	Grams	Grams	Grams	Grams	Gram
Total eaten (2121)	30,000	26,721	1,296	3,873	5,025	14,967	1,560
Total excreted (2105)	36,800	9,668	1,097	776	3,084	4,299	412
Digested	......	17,053	199	3,097	1,941	10,668	1.148
Per cent. digested	......	63.82	15.35	79.96	38.66	71.28	73.60
Horse 2.							
Total eaten (2121)	37,500	33,401	1,620	4,841	6,281	18,709	1,950
Total excreted (2111)	66,500	12,912	1,224	1,004	4,168	6,044	472
Digested	......	20,489	396	3,837	2,113	12,665	1,478
Per cent. digested	.. ...	61.34	24.45	79.26	33.65	67,70	75.80
Average for 2 horses	......	62.58	19.90	79.61	36.16	69.49	74.70
Pounds digestible in 100 lbs	......	55.7	0.8	10.3	6.0	34.7	3.9
Theoretical	......	......	... ..	9.5	48.9		3.7

Nutritive Ratio Found:—1:4.8.

Theoretical Nutritive Ratio:—1:5.9.

The results obtained in this test showed such a ration to be eaten better by the horses than either the ration of ground oats and new corn product or of ground oats and timothy hay. The digestibility of the nitrogen was found to be a little greater than according to theory and the carbohydrates less than according to theory, which made the ration give a narrower nutritive ratio than was calculated.

The following figures give the nitrogen assimilation and excretion in this and the preceding test:

Table XXXI.—Nitrogen Excretion and Assimilation in the New Corn Product Rations.

	Quantity of Urine. Grams.	Nitrogen. Per cent.	Quantity of Nitrogen in Urine. Grams.	Quantity of Nitrogen Assimilated Grams.	Difference. Grams.
In Ground Oats and New Corn Product Ration.					
Horse 1......	12,675	1.24	157.	362.4	Gain..205.2
Horse 2......	16,520	1.64	270.9	409.7	Gain..138.8
In Complete New Corn Product Ration.					
Horse 1......	12,760	1.85	236.0	495.5	Gain..259.5
Horse 2......	19,270	1.94	373.8	614.0	Gain..230.2

The gain of nitrogen assimilated in these rations over that excreted agrees, in a measure, with the weights recorded for the animals, but the gains in nitrogen and weights do not account for each other.

PROPORTIONS OF GRAIN AND HAY AND FEEDING STANDARDS FOR HORSES.

In studying the proportions of hay and grain fed horses it is not possible to give much consideration to the pratices of the American farmer X, as his methods, to say the least, are very indefinite, and in most cases will be found extremely wasteful. It is not uncommon to find a farmer feeding more grain than necessary, and it is the rule to feed much more hay than is really required, following these customs simply because he has them in abundance, and he takes no account of what is wasted by the animals. Probably the best guide in this matter on record is the investigation conducted by the American Institute Farmer's Club, as to the methods employed in large stables in New York City. They found that feeding the hay and grain as "mixed feed" was the general practice, and the method considered to give the best results. They also found that horses could be worked hard and kept in good condition on cut hay and corn meal. In practice they found the amount of hay fed varied from 8 to 14 lbs. per day in different stables, and of grain from 7 to 20 lbs. per day; the conclusion from the general average was that 10 lbs. of hay per day was sufficient for work horses, and grain from 15 to 18 lbs. per day.

The standard ration in the U. S. Army is 14 lbs. of hay per day and 12 lbs. per day of either oats, corn, or barley. This standard, I suppose, has been arrived at from the amounts used in practice, but the general observation has been that the hay allowance is greater than the horses will consume when on ordinary duty. A large lumberman, who keeps a great many horses for use in lumber wagons, &c., in speaking of this subject said, "that it had been their custom for a number of years to allow 12 lbs. per day for each horse, but had finally cut the amount down to from 6 to 8 lbs. per day, with the result that the horses did rather better, which he attributed to the fact that they would get more rest by this practice than when large quantities were fed and the horses would stand up and continue eating for the greater part of the night." These facts and experiences seem to corroborate the views of Spooner as given in his discussion of rations for horses where he says that "It seems evident that horses were intended by nature to consume concentrated food such as grain." And further it may be drawn from what he says that only the most nutritious bulky foods of good quality should be fed, and even these in but limited quantities to work animals.

THE FEEDING STANDARDS.

The German standard for horses heavily worked is to have a ration furnishing 2.3 lbs. digestible protein and 14.3 lbs. digestible carbohydrates and fat per day, which gives a nutritive ratio of 1:6.2. The standard of the U. S. Army of 14 lbs. of hay and 12 lbs. of oats per day, which is based on the requirements for heavy service, when estimated by the coefficients found in these experiments, would furnish 1.44 lbs. digestible protein and 12.93 lbs. digestible carbohydrates and fat, having a nutritive ratio of 1:9.0.

The German standard for horses lightly worked is 1.5 lbs. digestible protein and 10.4 lbs. digestible carbohydrates and fat per day, having a nutritive ratio of 1:6.9. From this we might conclude that if the German standard was applicable to our conditions, then our Army ration is not strong enough for heavy service work, and for light duty work there is a wasteful amount of the carbohydrates used, which in the bulky hay feed is not desirable for horses if it can be avoided.

Carrying out the same line of discussion with the average proportion arrived at from investigation of the American Institute Farmer's Club, there would be furnished by a ration of 10 lbs. of hay and 18 lbs. of oats, 2.1 lbs. of digestible protein and 11.5 lbs. digestible carbohydrates, having a nutritive ratio of 1:6, which would approximate the German standard for heavily worked horses. Should corn meal be substituted for the oats, as found in many cases, the ration would furnish 1.35 lbs. digestible protein and 17.20 lbs. digestible carbohydrates and fat, which would have a nutritive ratio of 1:13.6. This ration is deficient in nitrogen according to the German standards, but has considerable more carbohydrates. While it is being fed in practice to many horses in the United

States with fairly good results, at the same time the average life of a horse in the service of the cab and car companies, from which this data was obtained, was only about four years, which is entirely too short; and if the horses had received more nutritious food, especially more nitrogenous matter, it is quite probable they would have shown better endurance. The whole question of standard for horses is one that needs further investigation before the subject of horse feeding can be intelligently handled for American conditions.

TEST OF THE NEW CORN PRODUCT AS A SUBSTITUTE FOR HAY.

After the showing which the new corn product made in the digestion tests, and owing to the many ways and places where such a material could be utilized where it is now either too expensive or impracticable to use hay, it was determined to conduct further experiments with this product, and submit it to a test covering longer periods with more animals, and subjecting the horse to work. The work which was demanded of the horses was rather of a spasmodic character, and was such that there was no means for estimating the amount of it accurately; but was in amount and degree such as farm horses are generally required to perform.

There have been nine different horses used in making this test, including the two used for the digestion work. A record of this test will be given in the following pages:

TEST OF GROUND OATS AND TIMOTHY HAY vs. GROUND OATS AND NEW CORN PRODUCT.

This is the portion of the work conducted in connection with the digestion experiments, and is simply a summary of the observations for that time on those two horses. The horses were fed for two weeks on each of the rations indicated, and received the same care and exercise: the rations were only expected to serve for maintenance, and no work was demanded of the animals.

The following are the amounts of food eaten and the weights of the horses:

Length of Periods—14 Days Each.

	Horse No. 1.	Horse No. 2.
Timothy hay consumed	113 lbs.	123 lbs.
Grounds oats consumed	96 "	116 "
Total food	209 "	239 "
Weight at beginning of period	856 lbs.	946 lbs.
Weight at end of period	856 "	951 "
New corn product consumed	80 lbs.	101 lbs.
Ground oats consumed	79 "	101 "
Total food	159 "	202 "
Weight at beginning of period	832 lbs.	935 lbs.
Weight at end of period	833 "	940 "

(Note:—These periods were not consecutive, but had several other periods intervening when the loss in weight occurred.)

From these figures it will be noticed that both rations maintained the animals in their normal condition, but that there was considerable less eaten when on the new corn product ration. These periods were quite short, and consequently the results are only indicative, and would need to be confirmed by covering longer times.

TEST OF WORKING RATIONS.

To test the use of the new corn product as long forage for horses heavily worked, four farm horses were used from February 15th to March 15th. These horses were doing heavy hauling and farm work nearly every day of the entire time. These animals had been receiving, previous to this trial, 12 to 15 lbs. per day of timothy hay, and 15 to 18 lbs. per day of a grain mixture made of corn, oats, wheat bran and linseed meal, or a total of 27 to 30 lbs. per day. The ration used during the test was the following mixture:

New corn product	35 parts.
Hominy chop	25 "
Ground oats	10 "
Ground rye	10 "
Linseed meal	10 "
Gluten meal	5 "
Wheat bran	5 "
	100 "

This mixture would have approximately a nutritive ration of 1.6, and 20 lbs. would furnish approximately 2 lbs. digestible protein and 12 lbs. digestible carbohydrates.

The animals ate of this mixture from 18 to 24 lbs. per day. It was fed wet as mixed feed.

The weights were as follows:

	No. 3. Lbs.	No. 4. Lbs.	No. 5. Lbs.	No. 6. Lbs.
At beginning of test	1,274	1,314	1,314	1,230
At end of one month	1,280	1,320	1,314	1,236

On June 19th, two other horses were put on the same ration as given on page 36, and subjected to various conditions. They ate from 15 to 20 lbs. per day of this mixture, it being fed wet as mixed feed.

Horse No. 7 was either at rest or only light exercise, as she could not be driven.

Horse No. 8 was put on heavy farm work—mostly cultivating, but some wagoning, hay raking, &c.

	Horse No. 7. Lbs.	Horse No. 8. Lbs.
Weights at beginning	1,198	1,158
Weights at end of six weeks	1,214	1,160

Horse No. 7 was disposed of, and another one that would work with No. 8 put in her place. On August 2nd, these two horses were put on the same grain ration as the other horses on the farm, which consisted of a mixture of corn, oats, wheat bran and linseed meal. This grain ration was fed dry and by itself, and they were fed the new corn product wet and by itself instead of hay. The horses during this month were at either light work or driving. They ate 12 to 16 lbs per day of the grain, and 10 lbs. per day of the new corn product. The following were the weights:

	Horse No. 8. Lbs.	Horse No. 9. Lbs.
Weight at beginning of test	1,160	1,184
Weight at end of one month	1,176	1,246

During September the horses were placed on the following mixture:

New corn product	50 parts.
Corn meal	15 "
Ground oats	15 "
Ground rye	7½ "
Linseed meal	5 "
Gluten meal	7½ "
	100 "

This mixture has approximately a nutritive ratio of 1:7, and was a little different in its make up from that previously tried. It was fed as a "mixed feed," and the horse ate about the same quantities as in former periods. The weights are as follows:

	Horse No. 8. Lbs.	Horse No. 9. Lbs.
Weight at beginning of month	1,176	1,246
Weight at end of one month	1,204	1,270

During October the ration fed consisted of:

New corn product	10	parts.
Corn meal	6	"
Oats	3	"
Gluten meal	3	"
Total	22	"

This ration, it will be noticed, contained relatively less fodder than was in previous mixtures, but the amount is more nearly the proportion that was consumed during the August period and that which is used of hay.

	Horse No. 8. Lbs.	Horse No. 9. Lbs.
Weight at beginning of month	1,204	1,270
Weight at end of month	1,200	1,275

During November the ration given was new corn product for long forage and a mixture of oats, rye, linseed meal and gluten meal as the grain portion.

	Horse No. 8. Lbs.	Horse No. 9. Lbs.
Weight at beginning of month	1,200	1,275
Weight at end of one month	1,230	1,330

SUMMARY AS TO THE NEW CORN PRODUCT FOR HORSES.

In all, nine different animals have been fed on rations with the new corn product as a substitute for hay, and the only difficulty that has been experienced in feeding it was with two horses who had other horses beside them to whom hay was being fed. These animals became sullen and refused their feed, but on their next door neighbors being placed on the same ration they were receiving, all went along smoothly. All of these horses had been somewhat accustomed to a "mixed feed," so this form of ration was not so new to them as it would be perhaps to many horses. The horse that relished this form of ration best at the start was one that had been accustomed to eating wet brewer's grains, which would confirm the observation that in feeding animals there is much in habit and custom. Those who would attempt to feed this material for the first time had probably better start in by feeding the same hay and grain which the horses had been eating as a "mixed feed," and then after accustoming them to that, change to the other. From the fact that the horses ate this feed continuously for five months, and relished it more at the end than at the beginning, seemed satisfied at all times, together with the testimony of the weights is sufficient data for concluding that the new corn product is a good food for horses, and can replace hay for that purpose.

SUMMARY OF PRINCIPAL RESULTS.

1.—Timothy hay proved to be less digestible by horses than by ruminants.

2.—Grinding oats increased their digestibility.

3.—Corn meal was considerably more digestible than Shelled Corn.

4.—Feeding Concentrated Foods or grain with hay, decreased the digestibility of the hay.

5.—It is impossible to maintain horses on a grain ration alone; they must have a long forage.

6.—Making a "mixed feed," of the grain and long forage is the best manner of feeding horses.

7.—The new Corn Product was better digested by horses than Timothy Hay.

8.—Grinding fodder to the condition of the new corn product or of coarse bran does not destroy its value as long forage.

9.—The New Corn Product was successfully used as a substitute for hay in horse feeding.

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Errata:—Tenth Annual Report, page 164, line 8; read January 1st, instead of June 30th.

Bulletin No. 50 is the first bulletin in the 11th year of the Station, and begins the 11th volume; consequently its present paging is incorrect, and should have started at page 1, instead of 161. Those who bind the bulletins please note this correction.

MARYLAND

Agricultural Experiment Station.

BULLETIN NO. 52.

SPECIAL ISSUE.

COMPOSITION OF
COMMERCIAL FERTILIZERS
SOLD IN THIS STATE.

College Park, Md.

FEBRUARY, 1898.

MARYLAND
Agricultural Experiment Station.

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Located on the B. & O. R. R., 8 miles N. of Washington, D. C.

NOTICE.

NOTE: Under the laws of Maryland, the inspection, sampling and analysis of commercial fertilizers is to be done under the auspices of the Maryland Agricultural College, by the Professor of Chemistry of the College, who is ex-officio State Chemist. The results of these examinations, being agricultural information of value and general interest, will be published, from time to time, as Special Bulletins, from the Maryland Agricultural Experiment Station.

These Bulletins will be mailed, free, to any farmer who asks for them.

ADDRESS,

MARYLAND AGRICULTURAL EXPERIMENT STATION,
COLLEGE PARK, MD.

INSPECTION AND ANALYSIS OF

COMMERCIAL FERTILIZERS SOLD IN MARYLAND

BY THE CHEMICAL DEPARTMENT OF THE

MARYLAND AGRICULTURAL COLLEGE.

DR. H. B. MCDONNELL, *State Chemist.*
F. P. VEITCH, B. S., *Assistant Chemist.*
W. W. SKINNER, B. S., *Assistant Chemist.*
J. R. LAUGHLIN, B. S., *Assistant Chemist.*
H. T. WELTY, B. S., *Assistant Chemist.*

The analytical work for this bulletin has all been done in the new chemical laboratory of the College, a view of which is given on the first page. By referring to the plans on page numbered 51 it will be seen that two laboratories, together with a weighing room, with which they both communicate, and an office, are used exclusively for this work. One of the laboratories is used for the determination of phosphoric acid in fertilizers, while the other is used for the determination of potash and nitrogen (or "ammonia") the rest of the building is used for instruction in chemistry.

The greater part—88 or 90 per cent. of the samples analyzed for this bulletin have been drawn by the agents of the College from fertilizers in the hands of manufacturers, agents, transportation companies and farmers. Several agents spend the greater part of the fertilizer seasons traveling over the State for this purpose.

The other 10 or 12 per cent. of the samples are sent in by farmers who have the right, under the law, to send for analysis, samples of fertilizers "which they have purchased for their own use, *provided* they are not interested in the analysis otherwise than as a consumer of the fertilizer." Samples will *not be analyzed* for manufacturers or agents of fertilizers, nor for farmers unless a description of the sample and a certificate that it has been taken according to law, is furnished on the blanks of this Department. These blanks will be sent to farmers for the asking.

In the following table the figures under "Nitrogen," "Potash" and "Phosphoric Acid," indicate percentage or pounds of the respective ingredients in each hundred pounds of fertilizer, giving in parallel columns the amount "found" by analysis and that "guaranteed" by the manufacturer.

(NOTE—The fertilizer Law will be found on the last four pages of this bulletin.)

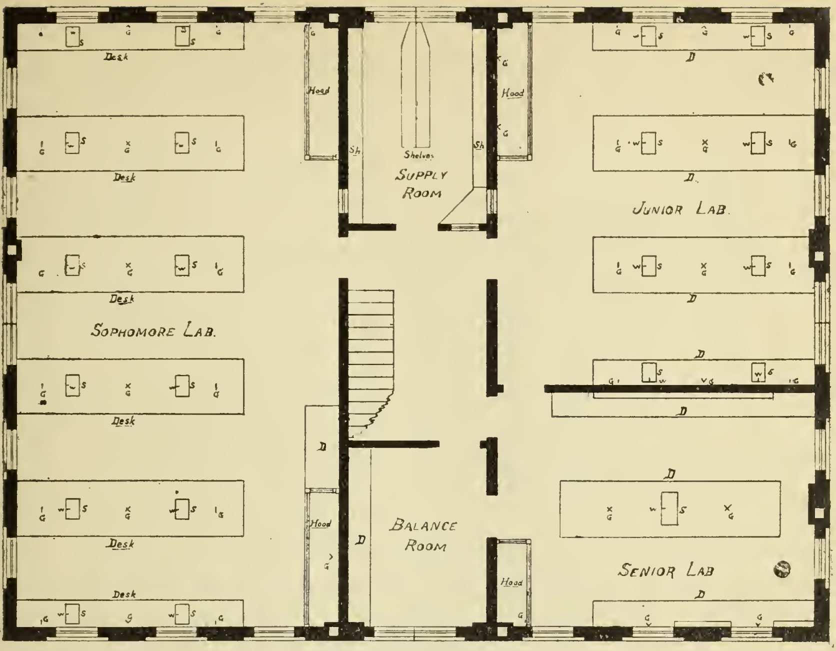
The "number" in the tables is that by which the samples are known in the laboratory, the "comparative value found" and the "comparative value guaranteed" are calculated, the former from the analysis found in the laboratory, the latter from the guaranteed analysis as printed on the bags, using the following schedule:

In Mixed Fertilizer:	
For Nitrogen, calculated as Ammonia	15 cts. per pound.
" Potash (K_2O), in forms free from muriate	6 " " "
" Potash (K_2O), as muriate	5 " " "
" Available Phosphoric Acid	5 " " "
" Insoluble Phosphoric Acid	2 " " "
" " " " when from S. C. Rock	1 " " "
In Dissolved S. C. Rock:	
Available Phosphoric Acid	3½ " " "
In Ground Bone:	
For Nitrogen, calculated as Ammonia, in "Fine" Bone	14 " " "
" Nitrogen, calculated as Ammonia, in "Fine Medium" Bone	12 " " "
" Nitrogen, calculated as Ammonia, in "Medium" Bone	10 " " "
" Nitrogen, calculated as Ammonia, in "Coarse" Bone	8 " " "
" Phosphoric Acid in "Fine" Bone	5 " " "
" " " " "Fine Medium" Bone	4 " " "
" " " " "Medium" "	3 " " "
" " " " "Coarse" "	2 " " "
In Tankage:	
For Nitrogen, calculated as Ammonia	12 " " "
" Phosphoric Acid	3 " " "
In Nitrate of Soda:	
For Nitrogen, calculated as Ammonia	10 " " "

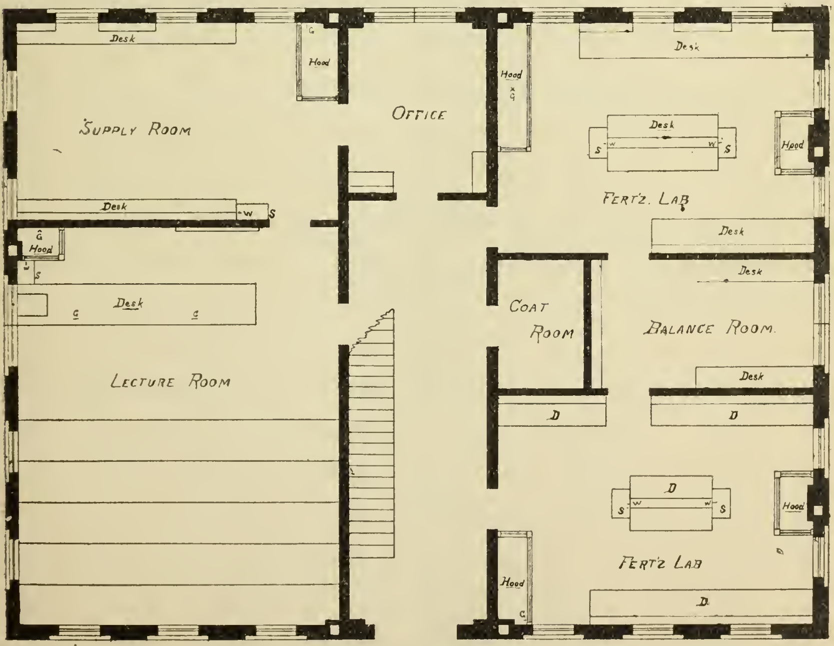
The above schedule is a reduction in phosphoric acid of 1 cent a pound in mixed fertilizers and 1½ cent in acid phosphates or dissolved S. C. Rock. This reduction is justified by the prevailing prices of this ingredient.

It will be noticed that, under this new schedule, fertilizers with the same analysis as in the previous bulletin are given a lower value.

Too much attention should not be given to these values. They are *not* intended to be the price that should be paid for the goods. For cash in the large markets, they can usually be bought for less. Freights, credits, commissions, etc., will always increase the cost.



SECOND FLOOR PLAN.



FIRST FLOOR PLAN.

Plans of New Chemical Laboratory, Maryland Agricultural College, 1897.

Table of Analysis and Valuation of Fertilizers Made at the

No.	Name and Address of Manufacturer.	Name of Fertilizer.	Place of Sampling.
4179	Alexandria Fert. & Chem. Co., Alexandria, Va.	Dissolved S. C. Rock...	Williamsport.......
4181	" " "	Pure Raw Bone Meal....	Hancock...........
4223	A. Anderson & Co., Mt Airy, Md.	Harvest Queen Guano..	Mt. Airy.... ......
4160	E. B. Arnold, Smallwood, Md.	Butcher House Bone....	Westminster........
4271	Baltimore Guano Co., Baltimore, Md.	Baltimore Special Wheat Mixture.	Secretary Wharf....
4147	" " "	B. G. Ammoniated Bone Phosphate.	Hampstead.........
4270	" " "	Farmer's Alkaline Bone	Secretary Wharf....
4140	" " "	Farmer's Dissolved Bone	Hampstead.........
4195	Baltimore Pulverizing Co.. Baltimore. Md.	Anti-acid Phosphate. ...	Germantown ....
4197	" " "	Crabster's Special Mixture.	Germantown........
4196	" " "	Farmer's Favorite Fertilizer.	Germantown ....
4127	Baltimore Seed & Implement Co., Baltimore, Md.	Ammoniated Soluble Bone Phosphate.	Baltimore...........
4212	Baugh & Sons Co., Baltimore, Md.	Animal Bone & Potash Compound.	Taneytown..........
4107	" " "	Bone Meal, Warranted Pure.	Baltimore...........
4128	" " "	Dissolved Steamed Bones.	Baltimore...........
4191	" " "	Double Eagle Phosphate	Gaithersburg.......
4110	" " "	Export Bone with Potash	Baltimore...........
4298	" " "	Fertilizer for Wheat and Grass.	Forest Hill..........
4108	" " "	General Crop Grower...	Baltimore...........
4209	" " "	H. G. Acid Phosphate or Dissolved S. C. Rock.	Middletown.........
4041	" " "	Mixture (S. C. Bone and Potash.)	Compton ....
4109	" " "	Old Stand-by Raw Bone Super Phosphate.	Baltimore...........
4182	" " "	Pure Dissolved Animal Bones.	Rockville ....

Maryland Agricultural College, August, 1897, to January, 1898, continued.

No.	NITROGEN Calculated as AMMONIA.		POTASH, K_2O.		PHOSPHORIC ACID.					Comparative Value per Ton Found.	Comparative Value per Ton Guaranteed.
						Available.		Total.			
	Found.	Guaranteed.	**Found.**	Guaranteed.	Insoluble Found.	**Found.**	Guaranteed.	**Found.**	Guaranteed.		
4179	....	....	....	....	.85	14.23	14	15.08	15½	$9.96	$ 9.80
4181	4.92	4	....	....	....	....	....	22.41	21½	31.10	....
4223	1.09	1	1.25	1	3.69	9.73	9	13.42	10	15.73	13.40
4160	1.90	1¾	1.83	1¾	1.08	9.30	8	10.38	....	17.26	15.00
4271	1.14	1	2.28	2	2.41	9.04	9	11.45	11	15.70	14.00
4147	1.75	1½	2.71	2	2.06	8.17	8	10.17	10	16.93	15.30
4270	....	....	2.26	2	2.49	9.37	10	11.86	12	9.32	9.00
4146	....	....	....	....	.89	15.10	14	15.99	15	10.57	9.80
4195	....	....	2.34	1¾	1.12	5.56	5¼	6.68	5½	6.45	5.82
4197	....	....	2.41	....	1.29	7.46	....	8.75	....	7.89	....
4196	.79	1	1.64	1¾	1.88	6.73	5½	8.61	10	11.49	10.60
4127	1.25	1	2.28	1½	1.58	7.48	7	9.06	8	14.14	11.90
4212	2.78	2	2.14	2	3.33	9.05	8	12.38	10½	20.86	17.00
4107	4.74	4	....	....	....	....	....	22.21	21½	30.85	....
4128	2.17	2	....	....	2.07	18.71	15	20.78	....	26.05	21.00
4191	2.88	2½	0.94	½	3.11	8.94	8	12.05	10½	19.76	17.00
4110	2.87	2	2.13	2	6 50	8.09	11	14.59	....	21 43	19.00
4298	2.47	2	2.01	2	1.03	9.86	8	10.89	....	19.69	16.00
4108	1.62	1	1.24	1	2.28	9.14	8	11.42	....	16.15	12.00
4209	....	....	....	....	1 41	14.58	14	15.99	15	10.21	9.80
4041	....	....	3.20	5	.84	11.78	10	12.62	....	11.63	12.00
4109	2.34	2	1.09	1	2.59	9.21	8	11.80	10½	18.36	16.00
4182	3.72	3	....	....	3.60	14.94	11	18.54	16	27.54	22.00

Table of Analysis and Valuation of Fertilizers Made at the

No.	Name and Address of Manufacturer.	Name of Fertilizer.	Place of Sampling.
4217	Baugh & Sons Co., Baltimore, Md.	Soluble Alkaline Super Phosphate.	Monrovia..........
4305	" " "	Tomato Compound.....	Aberdeen...........
4111	" " "	Wheat Fert. for Wheat & Grass.	Baltimore...........
4260	Beck, Walker & Brown, Chestertown, Md.	Propagator Super Phosphate.	Chestertown........
4261	" " "	Trustworthy	Chestertown........
4259	" " "	Try Me Super Phosphate	Chestertown........
4150	Wm. Bender, Jersey City, N. J.	Fertilizer................	Millers..............
4238	The Berg Company, Philadelphia, Pa.	Raw Bone Fine..........	Elkton..............
4210	A. D. Birely & Sons, Ladiesburg, Md.	Ammoniated Bone Phosphate.	Ladiesburg.........
4211	" " "	Dissolved Bones........	Ladiesburg..........
4283	Brumfield & Foster, Colora, Md.	Acid Phosphate & Potash.	Colora..............
4284	" " "	Ammoniated Bone Phosphate.	Colora ....
4294	" " "	Hard Times Ammoniated Phosphate.	Colora..............
4282	" " "	H. G. Acid Phosphate..	Colora..............
4178	D. Blocher & Co., Baltimore, Md.	H. G. Super Phosphate of Bone.	Hagerstown ....
4177	" " "	No. 1 Dissolved Bone....	Hagerstown........
4133	J. Bullock & Son, Baltimore, Md.	Pure Ground Raw Bone.	Baltimore...........
4151	Chemical Co., of Canton, Baltimore, Md.	Baker's Dissolved Bone Phosphate	Alesia...............
4193	" " "	Baker's Special Wheat Com. & Grass Mixture	Gaithersburg ......
4299	" " "	Baker's Standard Ground Bone.	Belair...............
4172	" " "	Dissolved Animal Bone.	Loys................
3613	" " "	Pure Dissolved S. C. Bone.	Maddox ....
4237	" " "	Pure Dissolved S. C. Bone.	Ellicott City........

Maryland Agricultural College, August, 1897, to January, 1898, continued.

No.	NITROGEN Calculated as AMMONIA.		POTASH, K_2O.		PHOSPHORIC ACID.					**Comparative Value per Ton Found.**	Comparative Value per Ton Guaranteed.
					Insoluble Found.	Available.		Total.			
	Found.	Guaranteed.	**Found.**	Guaranteed.		**Found.**	Guaranteed.	**Found.**	Guaranteed.		
4217	....	....	2.08	2	1.88	10.52	10	12.40	....	$ 9.81	$ 9.00
4305	2.01	2	2.60	2	3.02	11.16	8	14.18	....	21.00	16 80
4111	2.54	2	2.18	2	3.46	8.90	8	12.36	11	20.08	16.00
4260	1.01	1	2.80	2	2.42	9.51	10	11.93	....	16.31	15.00
4261	1.51	1½	2.63	2	1.14	8.94	10	10.08	....	16.56	16.50
4259	~~.11~~	~~1~~	3.01	3	1.73	8.84	10	10.57	11½	9.55	~~16.60~~ 10.
4150	5.17	5.13	.....	....	9.52	7.46	8.30	16.98	16.27	26.78	26.88
4238	4.86	4	.....	....	....	....	....	23.61	20	28.76	......
4210	.69	½	1.20	1	2.44	8.41	8	10.85	10	12.66	11.30
4211	2.55	2	.....	....	2.89	9.74	10	12.63	13¾	18.55	17.50
4283	....	....	2.12	2	1.61	11.52	11	13.13	....	10.50	9.70
4284	2.03	2	1.90	2	1.53	10.32	9	11.85	10	18.92	17.40
4294	1.21	1	1.04	1	1.55	11.60	10	13.15	11	16.89	14.40
4282	....	....	.....	....	.78	14.61	14	15.39	....	10.23	9.80
4178	1.58	2	1.43	2	2.91	10.20	8	13.11	10	17.53	16.80
4177	1.14	1	.....	....	1.97	12.40	10	14.37	12	16.61	13.80
4133	6.07	4.92	.....	....	.....	....	....	19.08	19.06	30.32	.....
4151	.26	¼	.....	....	2.00	12.70	13	14.70	15	14.28	14.55
4193	1.70	1	2.50	2	2.54	8.76	9	11.30	11	17.38	14.80
4299	4.23	4	...	....	....	....	....	19.50	20	27.04	......
4172	2.27	2½	.....	....	2.83	11.27	12	14.10	....	19.21	19.50
3613	....	....	....	....	.54	15.38	13	15.92	....	10.77	9.10
4237	....	....	.....	....	1.70	14.01	14	15.71	....	9.81	9.80

Table of Analysis and Valuation of Fertilizers Made at the

No.	Name and Address of Manufacturer.	Name of Fertilizer.	Place of Sampling.
4161	Chemical Co., of Canton Baltimore, Md.	Red Clover	Westminster
4232	" " "	Soluble Bone and Potash	Ellicott City
4288	R. L. Christy & Co., Colora, Md.	Farmer's Famous Bone Phosphate.	Colora
4287	" " "	Raw and Dissolved Bone Mixture.	Colora
4285	" " "	Soluble Bone and Potash	Colora
4295	" " "	Special for Wheat and Grass.	Rowlandsville
4286	" " "	Unexcelled Acid Phosphate.	Colora
4290	E. A. Clendennin & Bro., Colora, Md.	Farmer's Favorite Vegetator.	Colora
4239	" " "	Fine Ground Bone	Elkton
4292	" " "	H. G. Acid Phosphate	Colora
4289	" " "	National Standard	Colora
4291	" " "	Pure Ground Bone	Colora
4138	" " "	Soluble Bone Phosphate	Baltimore
4180	" " "	T. & P. Super Phosphate	Hancock
4293	" " "	Wheat and Grass Special Compound.	Colora
4296	Josiah Cope, Lincoln University. Pa.	Ammoniated Bone Phosphate.	Conowingo
4124	Edward L. Coulson, Baltimore, Md.	Pure Fine Ground Bone	Baltimore
4202	Crocker Fertilizer Co., Buffalo, N. Y.	H. G. Cereal Guano	Walkersville
4200	" " "	New Rival Ammoniated Super Phosphate.	Adamstown
4203	" " "	Practical Ammoniated Super Phosphate.	Walkersville
4216	Cutshall & Stimmel. Woodsboro, Md.	Ammoniated Bone Phosphate.	Monrovia
4304	Wm. Davison & Co., Baltimore, Md.	Bos Ammoniated Super Phosphate.	Belair
4302	" " "	H G. Ammoniated Super Phosphate.	Belair

Maryland Agricultural College, August, 1897, to January, 1898, continued.

No.	NITROGEN Calculated as AMMONIA.		POTASH, K_2O.		PHOSPHORIC ACID.					Comparative Value per Ton Found.	Comparative Value per Ton Guaranteed.
						Available.		Total.			
	Found.	Guaranteed.	**Found.**	Guaranteed.	Insoluble Found.	**Found.**	Guaranteed.	**Found.**	Guaranteed.		
4161	**1.10**	1	**2.11**	2	2.25	**5.53**	5	**7.78**	6	**$11.84**	$10.00
4232	....	....	**2.22**	2	1.99	**9.69**	10	**11.68**	....	**9.40**	9.00
4288	**1.37**	1	**1.87**	2	3.41	**9.85**	8	**13.26**	10	**17.19**	13.80
4287	**2.43**	2¼	**4.03**	4	3.00	**10.92**	9	**13.92**	13½	**23.44**	21.55
4285	....	....	**1.75**	2	2.40	**11.87**	11	**14.27**	13	**10.54**	10.10
4295	**2.20**	2	**1.82**	2	2.97	**9.05**	10	**12.02**	13	**18.66**	19.20
4286	....	....	....	....	1.98	**14.02**	14	**16.00**	16	**9.81**	9.80
4290	**1.15**	1	**.83**	1	2.11	**7.13**	8	**9.24**	9	**12.25**	12.40
4239	**4.75**	4	....	....	....	....	....	**22.46**	22	**26.41**	....
4292	....	....	....	....	1.76	**14.57**	14	**16.33**	....	**10.20**	9.80
4289	**1.07**	1½	**2.03**	1½	1.81	**7.94**	10	**9.75**	13	**13.90**	17.20
4291	**4.69**	4	....	....	....	....	....	**22.27**	22	**26.20**	....
4138	....	....	**2.20**	2	3.88	**8.59**	10	**12.47**	11	**8.99**	9.20
4180	....	....	....	....	2.22	**13.40**	16	**15.62**	....	**9.38**	11.20
4293	**1.07**	1¼	**1.54**	2	1.80	**7.65**	9	**9.45**	....	**13.12**	14.75
4296	**1.07**	1	**2.85**	2	2.10	**10.62**	10	**12.72**	12	**17.52**	15.80
4124	**4.43**	....	....	....	....	....	....	**22.27**	....	**29.12**	....
4202	**1.22**	1	**1.68**	2	1.16	**7.36**	8	**8.52**	9	**13.16**	13.40
4200	**1.58**	1½	**1.75**	1.60	1.40	**9.70**	10	**11.10**	11	**16.75**	16.50
4203	**1.31**	1	**1.52**	1	1.87	**8.23**	8	**10.10**	9	**14.43**	12.40
4216	**1.02**	1	**2.13**	1	1.36	**9.37**	8	**10.73**	....	**15.10**	12.00
4304	**2.52**	2½	**2.56**	2½	2.06	**10.55**	8	**12.61**	11	**21.49**	19.20
4302	**2.98**	2¾	**3.10**	2¾	2.17	**12.42**	10	**14.59**	13	**25.33**	22.20

Table of Analysis and Valuation of Fertilizers Made at the

No.	Name and address of Manufacturer.	Name of Fertilizer.	Place of Sampling.
4303	Wm. Davison & Co., Balmore, Md.	Penn Mar Ammoniated Bone Phosphate.	Belair..............
4229	E. E. De Lashmutt, Frederick, Md.	Dissolved S. C. Bone....	Woodbine ....
4205	" " "	Mixture — Ammoniated Bone.	Frederick..........
4206	" " "	Mixture—Fish and Bone	Frederick..........
4207	" " "	Mixture—Soluble Bone..	Frederick..........
4208	" " "	Mixture—Soluble Bone and Potash.	Frederick..........
4269	Lewis F. Detrick, Baltimore, Md.	Bone and Potash Mixture.	Pocomoke ....
4246	" " "	Kangaroo Komplete Kompound.	Baltimore..........
4139	" " "	Orchilla Guano..........	Baltimore..........
4247	" " "	Orchilla Guano and Potash	Baltimore..........
*4035	" " "	Soluble Bone Phosphate and Potash.	Kemptown.........
4267	" " "	XXTRY Acid Phosphate	Snow Hill.........
4244	Detrick Fert. & Chemical Co., Baltimore, Md.	Alkaline Bone...........	Baltimore..........
4145	" " "	Carroll Mixture.........	Hampstead........
4201	" " "	Dissolved Bone.........	Frederick..........
4198	" " "	Dissolved S. C. Bone....	Barnesville.........
4264	" " "	Emory's Bone and Potash.	Queen Anne's.....
4199	" " "	Farmer's Friend........	Adamstown ....
4224	" " "	Farmer's New Method..	Mt. Airy...........
4225	" " "	Imperial Compound.....	Mt. Airy...........
4103	" " "	Pure Fine Ground Animal Bone.	Locust Point.......
4228	" " "	Sea Fowl Guano........	Mt. Airy...........
4230	" " "	Soluble Bone Phosphate and Potash.	Marriottsville......

*Brand of the Detrick Fertilizer and Chemical Company.

Maryland Agricultural College, August, 1897, to February, 1898, continued.

No.	NITROGEN Calculated as AMMONIA.		POTASH, K_2O.		PHOSPHORIC ACID.					Comparative Value per Ton Found.	Comparative Value per Ton Guaranteed.
						Available.		Total.			
	Found.	Guaranteed.	Found.	Guaranteed.	Insoluble Found.	Found.	Guaranteed.	Found.	Guaranteed.		
4303	1.80	1.40	2.15	2½	2.81	7.41	8	10.22	10	$16.08	$15 50
4229	....	....	....	....	.56	15.32	14	15.88	....	10.72	9.80
4205	1.32	1½	1.71	¾	1.50	10.84	10	12.34	....	17.11	15.25
4206	1.64	2¼	.92	¾	1.69	11.15	10	12.84	....	17.67	17.50
4207	.90	¾	.74	¾	1.20	13.35	9	14.55	....	17.27	12.00
4208	....	....	1.61	1½	.52	13.74	10	14.26	....	11.34	8.50
4269	....	....	2.26	2¼	1.76	10.82	10	12.58	12½	10.18	9.75
4246	2.07	2	3.37	3	3.86	7.50	8	11.36	11½	18.62	18 40
4139	....	....	..	....	10.97	5.25	....	16.22	14	5.87	2.80
4247	....	....	2.69	3	6.57	6.42	4	12.99	12	8.49	7.40
4035	....	....	2.25	2	1.82	10.27	10	12.09	12	9.79	9 40
4267	....	....	....	....	1.03	14.12	14	15.15	14.75	9.88	9.80
4244	....	....	2.39	2	2.93	9.86	10	12.79	12	9.88	9.40
4145	1.36	1	2.04	2	2.20	10.55	9	12.75	10	17.55	14.40
4201	2.37	2½	....	....	3.50	10.39	10	13.89	12	18.90	18.30
4198	....	....	....	....	.71	14.70	14	15.41	15	10.29	9.80
4264	....	....	2.82	....	2.10	9.90	....	12.00	....	10.17	......
4199	1.19	1	1.11	1	3.06	9.26	8	12.32	10	15.16	12.80
4224	2.52	2½	....	....	2.69	9.78	8	12.47	....	18.42	15.50
4225	1.10	1	1.04	1	1.93	10.62	9	12.55	10	15.73	13.40
4103	4.81	4	....	....	.....	.....	....	22.76	21½	30.85	......
4228	2.77	2.90	2.26	2	4.59	9.46	8	14.05	9¾	21.87	19.40
4230	....	....	2.10	2	2.50	9.93	10	12.43	12	9.55	9.40

Table of Analysis and Valuation of Fertilizers Made at the

No.	Name and Address of Manufacturer.	Name of Fertilizer.	Place of Sampling.
4226	Detrick Fert. & Chemical Co., Baltimore, Md.	Special Mixture.........	Mt. Airy...........
4227	" " "	Vegetator...............	Mt Airy...........
4144	" " "	Wheat Fertilizer........	Baltimore..........
4231	J. W. Dorsey, Ellicott City, Md.	"D" Mixture............	Ellicott City.......
*4306	Josh. W. Dorsey, Ellicott City.	Mixture "D"....	Ellicott City.......
4274	Draper, Davis & Co., Milford, Del.	Bone Phosphate, Jumbo.	Linkwood..........
4273	" " "	Old Reliable XX Raw Bone Super Phosphate	Linkwood..........
4272	" " "	Rock..................	Linkwood..........
4297	P. P. Dunan, Baltimore, Md.	Ammoniated Alkaline Phosphate.	Cambria...........
4168	D. Englar, Jr., Medford, Md.	No. 1 Bone Phosphate...	Medford ....
4167	" " "	No. 3 Bone Phosphate...	Medford............
4170	Englar & Rinehart, Linwood, Md.	No. 1 Ammoniated Bone Phosphate.	Linwood..........
4169	" " "	No. 2 Ammoniated Bone Phosphate.	Linwood ....
4278	Eureka Fertilizer Co., Perryville, Md.	AlkalineBone and Potash	Rising Sun.........
4281	" " "	Bone Meal..............	Rising Sun.........
4277	" " "	Farmer's Favorite Bone Fertilizer.	Rising Sun.........
4240	" " "	Fish Rock and Potash..	Leslie..............
4280	" " "	Grain and Grass Mixture	Rising Sun.........
4241	" " "	Imperial Bone Phosphate	Leslie..............
4276	" " "	P. & P. Super Phosphate	Rising Sun.........
4149	Farmer's Fertilizer Co., Westminster, Md.	No. 1 Bone Phosphate...	Maple Grove.......
4157	" " "	No. 2 Bone Phosphate...	Westminster ....

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*This is a second brand of the "Mixture D," which was put on the market during the season.

Maryland Agricultural College, August, 1897, to January, 1898, continued.

No.	NITROGEN Calculated as AMMONIA.		POTASH, K_2O.		PHOSPHORIC ACID.					Comparative Value per Ton Found.	Comparative Value per Ton Guaranteed.
						Available		Total.			
	Found.	Guaranteed.	**Found.**	Guaranteed.	Insoluble Found.	**Found.**	Guaranteed.	**Found.**	Guaranteed.		
4226	**1.10**	1	**1.10**	1	1.68	**10.85**	8	**12.53**	10	**$15.92**	$12.80
4227	**2.46**	2½	**1.52**	1½	4.07	**10.45**	10	**14.52**	12	**20.98**	19.80
4144	**1.45**	1¼	.....	....	3.05	**10.71**	10	**13.76**	11	**16.28**	14.15
4231	**1.85**	2¼	**2.11**	2	1.71	**11.36**	10	**13.07**	11½	**19.70**	19.35
4306	**2.29**	2¼	**2.57**	2½	1.99	**10.64**	10	**12.63**	11½	**20.88**	19.85
4274	**1.12**	1	**1.74**	1	3.76	**9.24**	8	**13.00**	....	**15.84**	12.00
4273	**1.37**	½	**1.92**	½	4.20	**8.63**	8	**12.83**	....	**16.34**	10.00
4272	.....	....	.....	....	3.79	**12.17**	....	**15.96**	....	**8.52**	......
4297	**2.49**	2	**2.30**	1	2.65	**10.49**	8	**13.14**	12	**21.32**	15.80
4168	**2.87**	2½	**1.82**	2	3.44	**8.77**	8½	**12.26**	11½	**20.58**	19.20
4167	**1.70**	1½	**2.74**	2	1.86	**9.31**	9½	**11.17**	11	**17.89**	16.60
4170	**2.53**	2½	**1.20**	1.34	2.21	**10.59**	11.31	**12.80**	... ...	**20.26**	20.15
4169	**1.02**	1.80	**2.84**	1.83	2.73	**8.93**	11.99	**11.66**	....	**15.92**	19.22
4278	.....	....	**1.53**	2	2.05	**11.35**	11	**13.40**	12	**9.89**	9 90
4281	**3.46**	3	. ...	....	. ..	.....	....	**25.05**	25	**31.57**	......
4277	**1.32**	2	**3.33**	2	3.41	**9.64**	10	**13.05**	12	**18.29**	18 80
4240	**.76**	½	**1.40**	½	4 70	**7.84**	7	**12.54**	9	**13.40**	9.80
4280	**1.23**	1	**2.15**	2	3.66	**9.73**	9	**13.39**	10	**17.03**	14.40
4241	**1.24**	1	**1.71**	1	3.20	**9.93**	9	**13.13**	10	**16.64**	13.00
4276	.....	....	.....	....	2.00	**13 62**	14	**15.62**	15	**9.53**	9.80
4149	**2.66**	2½	**2.28**	2½	.78	**9.44**	9	**10.22**	11	**20.01**	19.80
4157	**2.12**	2	**1.92**	2½	1.11	**9.99**	9	**11.10**	10	**18.71**	17.90

Table of Analysis and Valuation of Fertilizers Made at the

No.	Name and Address of Manufacturer.	Name of Fertilizer.	Place of Sampling.
4156	Farmer's Fertilizer Co., Westminster, Md.	No. 3 Bone Phosphate...	Westminster........
4155	" " "	Pure Dissolved Bone....	Westminster........
4148	" " "	XX Bone Phosphate.....	Maple Grove........
4248	W. S. Farmer & Co., Baltimore, Md.	B. & P. Fertilizer........	Baltimore...........
4275	" " "	Dissolved S. C. Bone...	Cambridge..........
4137	" " "	Harvest Queen..........	Baltimore...........
4158	N. I. Gorsuch & Son, Westminster, Md.	Westminster Dis. Raw Bone Phosphate.	Westminster ....
4159	" " "	Westminster No. 3 Bone XXXX.	Westminster ....
4171	Griffith & Boyd, Baltimore, Md.	Ammoniated Soluble Bone.	Union Bridge.......
4252	" " "	Ammoniated Bone Phosphate.	White Hall..........
4136	" " "	Cereal Bone Plant Food.	Baltimore.... ......
4105	" " "	H. G. Acid Phosphate..	Baltimore...........
4134	" " "	Peerless Fertilizer......	Baltimore...........
4101	" " "	Pure Dissolved Animal Bone.	Baltimore...........
4106	" " "	Pure Fine Ground Bone Meal.	Baltimore...........
4135	" " "	Soft Ground Bone.......	Baltimore...........
4045	" " "	Special Mixture..........	Freedom ....
4233	" " "	Valley Fertilizer........	Ellicott City........
4112	Griffith, Turner & Co. Baltimore, Md.	Ammoniated Butchers' Bone Phosphate.......	Baltimore...........
4123	" " "	Animal Bone Phosphate.	Baltimore...........
4115	" " "	Strictly Pure Raw Bone Meal.	Baltimore...........
4164	Hanover Bone Fertilizer Co., Hanover, Pa.	Blood & Bone Compound	Westminster ....
4152	" " "	Hanover Dissolved Bone Phosphate.	Manchester..........

Maryland Agricultural College, August, 1897, to February, 1898, continued.

No.	NITROGEN Calculated as AMMONIA.		POTASH, K_2O.		PHOSPHORIC ACID.					Comparative Value per Ton Found.	Comparative Value per Ton Guaranteed.
						Available.		Total.			
	Found.	Guaranteed.	**Found.**	Guaranteed.	Insoluble Found.	**Found.**	Guaranteed.	**Found.**	Guaranteed.		
4156	1.87	1½	2.59	2½	1.16	9.78	7	10.94	....	$18.44	$14.00
4155	2.52	2	....	....	6.30	9.94	15	16.24	....	20.02	21.00
4148	1.04	1	3.19	3	1.06	10.13	9	11.19	10	16.86	15.40
4248	....	....	2.13	2½	1.94	10.73	10	12.67	11	10.03	9.70
4275	....	......	....	......	2.31	13.07	14	15.38	15½	9.15	9.80
4137	1.63	1½	3.07	2½	1.17	10.10	10	11.27	....	18.53	17.60
4158	1.48	1.40	2.41	2¼	2.17	8.03	7	10.20	8	15.75	13.85
4159	.39	¼	2.13	1½	2.84	7.20	8	10.04	9	11.64	10.65
4171	1.10	1	1.98	1½	1.68	7.09	7	8.77	8	13.04	11.90
4252	1.95	1	2.44	1½	2.02	10.68	9	12.70	10	20.02	13.90
4136	1.11	1	2.58	2	2.22	8.08	8	10.30	10	14.88	13.80
4105	....	......	....	....	2.45	12.40	14	14.85	15	8.68	9.80
4134	.35	¼	2.35	2	2.06	7.59	8	9.65	9	11.83	11.15
4101	2.12	2½	....	....	3.18	9.21	10	12.39	11	16.84	17.90
4106	5.61	4	....	... ...	....	....	....	19.23	22	26.77	......
4135	4.20	3	....	....	....	.....	....	13.10	11	21.85	......
4045	.58	½	2.55	2	3.13	7.46	8	10.59	9	13.01	11.90
4233	.53	½	2.50	2	1.80	7.49	8	9.29	9	12.30	11.90
4112	1.54	1½	2.09	1½	2.78	8.31	9	11.09	10	16.13	15.40
4123	2.01	2½	2.70	1½	2.90	9.71	10	12.61	11	19.92	19.40
4115	6.07	4	.....	....	.....	.....	....	18.16	23	27.88	......
4164	1.14	1	2.23	2	1.76	8.61	8	10.37	....	14.96	13.00
4152	.....	....	2.30	2	.80	10.90	8	11.70	9	10.09	7.80

Table of Analysis and Valuation of Fertilizers Made at the

No.	Name and Address of Manufacturer.	Name of Fertilizer.	Place of Sampling.
4163	Hanover Bone & Fertilizer Co., Hanover, Pa.	Excelsior Combine......	Westminster.......
4162	" " "	Farmer's Crop Winner..	Westminster.......
4166	" " "	Pure Bone Meal.	Westminster.......
4301	Hanway & Keen, Belair, Md.	Special Mixture.........	Belair..............
4142	" " "	H. & K. Standard H. G Guano	Baltimore..........
4249	S. M. Hess & Bro., Philadelphia, Pa.	Ground Bone............	Baltimore..........
4242	" " "	Keystone Bone Phosphate.	Leslie..............
4218	W. H. Hood, Mt. Airy, Md.	Special Mixture.........	Mt. Airy............
4113	J. Horner. Jr., & Co., Baltimore, Md.	Ammoniated Raw Bone Super Phosphate.	Baltimore..........
4114	" " "	Dis. Slaughter House Bone Dust.	Baltimore..........
4100	" " "	Slaughter House Bone Dust.	Baltimore ....
4266	Hubbard & Co., Baltimore, Md.	Climax Super Phosphate	Easton....... .....
4117	" " "	Columbia Gem Phosphate.	Baltimore..........
4265	" " "	Crescent Soluble Crop Producer.	Easton.............
4222	" " "	Dissolved Raw Bone....	Mt. Airy............
4118	" " "	H. G. Soluble S. C. Bone	Baltimore..........
3622	" " "	Muriate of Potash.......	Reliance...........
4220	" " "	Oriental Phosphate.....	Mt. Airy............
4194	" " "	Soluble Bone and Potash	Germantown.......
3620	" " "	S. C. Rock..............	Reliance...........
4219	" " "	Standard Bone Super Phosphate.	Mt. Airy............
3621	" " "	Tankage................	Reliance...........
4221	" " "	Warranted Pure Raw Bone.	Mt. Airy............

Maryland Agricultural College, August, 1897, to January, 1898, continued.

No.	NITROGEN Calculated as AMMONIA.		POTASH, K_2O.		PHOSPHORIC ACID.					Comparative Value per Ton Found.	Comparative Value per Ton Guaranteed.
					Insoluble Found.	Available.		Total.			
	Found.	Guaranteed.	**Found.**	Guaranteed.		**Found.**	Guaranteed.	**Found.**	Guaranteed.		
4163	2.06	2	3.35	3	1.65	9.36	9	11.01	10	$19.55	$18.40
4162	.67	½	1.84	1	1.09	8.93	7	10.02	....	13.22	9.50
4166	4.32	4	....	....	....	....	....	15.95	23	23.57	....
4301	1.42	1	2.29	2	2.55	8.74	9	11.29	11	16.31	14.80
4142	2.67	2½	2.83	2½	2.49	8.57	9	11.06	....	20.41	19.00
4249	4.98	3	....	....	....	....	....	22.10	22	26.81	....
4242	1.30	1	1.45	1	1.75	7.74	9	9.49	11	13.79	13.80
4218	1.41	1	2.73	2	.69	9.66	8	10.35	9½	16.90	13.60
4113	3.38	2½	1.59	2½	3.16	8.53	8	11.69	12	21.52	19.60
4114	2.81	2½	....	....	5.14	11.84	12	16.98	15	22.32	20.70
4100	6.90	6.00	....	....	....	....	....	19.55	20	32.36	....
4266	1.12	1	1.53	1½	1.12	9.34	8	10.46	10	14.68	13.30
4117	.92	½	1.70	1½	1.12	10.23	8	11.35	10	15.14	11.80
4265	....	....	....	....	1.44	11.43	10	12.87	11	8.00	7.00
4222	2.79	2¾	....	....	4.51	10.15	11	14.66	....	20.32	19.25
4118	....	....	....	....	.98	15.16	14	16.14	14	10.61	9.80
3622	....	....	35.82	52	....	....	....	....	....	....	....
4220	1.21	1	1.51	1½	1.06	9.62	8	10.68	10	15.18	13.30
4194	....	....	2.14	2	.88	10.47	10	11.35	11½	9.68	9.30
3620	....	....	....	....	1.48	14.18	14	15.66	....	9.93	9.80
4219	1.14	2	2.07	2	.87	10.34	9	11.21	10	16.18	17.40
3621	8.05	10	....	....	3.39	4.07	....	7.46	10	23.79	....
4221	4.55	4	....	....	....	....	....	23.11	23	27.40	....

Table of Analysis and Valuation of Fertilizers Made at the

No.	Name and Address of Manufacturer.	Name of Fertilizer.	Place of Sampling.
4116	Hubbard & Co., Baltimore, Md.	Wheat Grower's Jewel..	Baltimore...... ....
4268	M. P. Hubbard & Co., Baltimore, Md.	Ammoniated Bone and Potash.	Pocomoke..........
4122	“ “ “	Harvest King...........	Baltimore..... ....
4121	“ “ “	Farmer's Old Economy.	Baltimore ....
3616	“ “ “	Farmer's Old Economy.	Greensboro ....
4255	“ “ “	Soluble Bone and Potash Phosphate.	Baltimore...........
4256	T.R. Hubbard & Son, Chestertown, Md.	Imperial Compound.....	Chestertown........
4257	“ “ “	Special Mixture.........	Chestertown........
4143	T. C. Hunter, White Hall, Md.	Extra Ammoniated Bone Phosphate.	Baltimore ....
4120	S. L. Lamberd Co., Baltimore, Md.	Favorite Fertilizer......	Baltimore...........
4214	Lazaretto Guano Co., Baltimore, Md.	Alkaline Phosphate.....	Woodsboro........ .
4039	“ “ “	Alkaline Phosphate.....	Plane No. 4.........
4185	“ “ “	Ammoniated Bone Phosphate.	Washington Grove..
4236	“ “ “	Bone Compound.......	Ellicott City........
4188	“ “ “	Crop Grower for Wheat and Fall Crops.	Washington Grove..
4234	“ “ “	Forcythe & Linthicum Mixture.	Ellicott City........
4213	“ “ “	Harford Bone...........	Taneytown ....
4250	“ “ “	H. G. Dis. Bone Phosphate and Potash.....	Baltimore...........
4186	“ “ “	Pure Dissolved Animal Bone.	Washington Grove..
4215	“ “ “	Pure Dissolved S. C. Bone.	Woodsboro.........
4235	“ “ “	Pure Ground Bone......	Ellicott City ....
4183	“ “ “	Retriever Animal Bone Fertilizer	Washington Grove..
4176	A. A. Lechlider, Hagerstown, Md.	Eagle Bone Phosphate..	Hagerstown ....

Maryland Agricultural College, August, 1897, to January, 1898, continued.

No.	NITROGEN Calculated as AMMONIA.		POTASH, K_2O.		PHOSPHORIC ACID.					Comparative Value per Ton Fonnd.	Comparative Value per Ton Guaranteed.
						Available.		Total.			
	Found.	Guaranteed.	**Found.**	Guaranteed.	Insoluble Found.	**Found.**	Guaranteed.	**Found.**	Guaranteed.		
4116	**1.74**	1½	**1.52**	1½	1.67	**10.82**	10	**12.49**	11	**$18.23**	$16.40
4268	**1.11**	1	**1.52**	1½	.80	**9.16**	8	**9.96**	9½	**14.33**	13.10
4122	**1.74**	1½	**1.98**	1½	1.25	**10.25**	9	**11.50**	10½	**17.95**	15.60
4121	**.99**	1½	**1.67**	1½	1.39	**8.83**	8	**10.22**	10	**13.53**	11.80
3616	**1.05**	½	**1.54**	1½	1.35	**9.32**	8	**10.67**	10	**11.75**	9.40
4255	....	....	**1.74**	2	.43	**10.63**	10	**11.06**	12	**9.27**	9.40
4256	**1.02**	1	**2.32**	3½	1.24	**10.60**	9	**11.84**	10	**16.48**	15.50
4257	**.52**	....	**1.88**	....	1.05	**9.83**	....	**10.88**	....	**13.69**	......
4143	**1.64**	1½	**4.08**	4	1.39	**9.08**	8	**10.47**	....	**18.64**	16.50
4120	**2.11**	2	**1.97**	1	2.29	**7.66**	8	**9.95**	9	**16.88**	15.40
4214	.....	....	**1.88**	2	1.10	**11.72**	11	**12.82**	12	**10.30**	9.90
4039	....	....	**2.07**	2	1.17	**11.72**	11	**12.89**	....	**10.49**	9.70
4185	**1.10**	1	**2.32**	2	1.30	**9.80**	9	**11.10**	10	**15.94**	14.40
4236	**1.30**	1¼	**2.37**	2½	1.53	**9.74**	10	**11.27**	11	**16.62**	16 65
4188	**2.17**	2	**2.29**	2	1.45	**10.12**	10	**11.57**	11	**19.50**	18.40
4234	**2.53**	2¼	**4.47**	4	3.55	**10.34**	9	**13.89**	13½	**23.82**	21.55
4213	**3.49**	3	.....	....	.....	....	....	**17.68**	16	**22.53**	......
4250	.....	....	**3.28**	2	1.00	**12.53**	12	**13.53**	....	**12.25**	10.40
4186	**2.72**	2½	.....	....	3.40	**13.40**	12	**16.80**	....	**22.92**	19.50
4215	.....	....	. ..	......	1.42	**14.82**	14	**16.24**	15	**10.37**	9.80
4235	**4.92**	4½	....	......	...	....	....	**22.95**	21½	**27.73**	......
4183	**2.42**	2¼	**4.10**	4	3.60	**10.66**	9	**14.26**	13½	**23.46**	21.55
4176	**.51**	1½	**1.67**	1½	1.30	**4.31**	7½	**5.61**	9	**8.03**	14.10

Table of Analysis and Valuation of Fertilizers Made at the

No.	Name and Address of Manufacturer.	Name of Fertilizer.	Place of Sampling.
4175	A. A. Lechlider, Hagerstown, Md.	Soluble Bone Phosphate.	Hagerstown
4174	" " "	S. C. Bone	Hagerstown
4253	Lister Agrl. Chem. Works, Newark, N. J.	Animal Bone and Potash	White Hall
4245	" " "	Ammoniated Dissolved Bone Phosphate.	Baltimore
4102	" " "	Celebrated Ground Bone Acidulated.	Baltimore
4190	" " "	Harvest Queen	Washington Grove
4187	" " "	Pure Raw Bone Meal	Washington Grove
4104	" " "	Special Crop Producer	Baltimore
4141	" " "	Special Fertilizer for Wheat.	Baltimore
4254	" " "	Special for Wheat and Grass.	Glencoe
4184	" " "	Standard Pure Bone Super Phosphate.	Washington Grove
4192	" " "	Success Fertilizer	Gaithersburg
4173	Joseph Lister, Chicago, Ill.	Pure Bone Meal	Chewsville
4154	J. A. Livers, Baltimore, Md.	Gold Dust	Westminster
4262	T. H. Longfellow, Greensboro, Md.	Farmer's Delight No. 1	Greensboro, Md.
3615	" " "	Farmer's Delight No. 1	Greensboro
4043	" " "	Farmer's Special Mixture.	Ridgeley
4038	" " "	Muriate of Potash	Greensboro
3617	" " "	Special Mixture	Greensboro
4037	" " "	Special Mixture	Greensboro
4263	" " "	Wheat Grower	Greensboro
4413	Maryland Fertilizer Co., Baltimore, Md.	Ammoniated O. K. Fertilizer.	Hagerstown
4369	" " "	Dissolved S. C. Bone	Baltimore

Maryland Agricultural College, August, 1897, to February, 1898, continued

No.	NITROGEN Calculated as AMMONIA.		POTASH, K_2O.		PHOSPHORIC ACID.					Comparative Value per Ton Found.	Comparative Value per Ton Guaranteed.
						Available.		Total.			
	Found.	Guaranteed.	**Found.**	Guaranteed.	Insoluble Found.	**Found.**	Guaranteed.	**Found.**	Guaranteed.		
4175	.39	1	2.18	1	1.82	2.86	6½	4.68	7	$ 6.94	$10.70
4174	.....	....	1.67	1	1.30	3.33	6	4.63	....	4.26	5.20
4253	.....	....	5.03	5	1.36	9.61	9	10.97	10	12.03	11.50
4245	2.23	2.20	2.23	1½	2.27	10.44	9	12.71	10	20.34	17.50
4102	4.13	3¼	....	....	6.54	7.48	....	14.02	12	22.49	......
4190	1.76	1½	2.25	2	1.68	10.77	9½	12.45	11½	19.02	16.80
4187	3.41	3¼	.....	....	....	.....	....	24.35	23	27.97	......
4104	1.18	1	1.22	1	2.93	7.17	7	10.10	8	13.10	11.40
4141	2.13	2	2.10	2	3.04	8.67	8	11.71	....	18.42	16.00
4254	2.09	2	2.02	2	2.11	10.41	10	12.52	11	19.84	18.64
4184	2.83	2.85	2.05	1½	1.37	12.35	10	13.72	12	23.44	20.85
4192	1.79	1½	2.31	2	1.51	11.76	9½	13.27	11½	20.11	16.80
4173	4.24	4.68	.....	....	.....	....	....	24.69	25	31.85	.....
4154	1.59	1	2.05	1	1.15	11.08	9	12.23	10½	18.36	13.60
4262	1.20	1	2.48	2	2.48	9.47	8	11.95	9	16.54	13.40
3615	1.37	1	2.62	2	.74	8.92	8	9.66	9	15.95	13.40
4043	2.20	....	5.83	....	4.25	8.47	....	12.72	....	22.50	......
4038	.....	....	50.54	....	.....	.....	....	.....	....	40.44	......
3617	.....	....	3.85	....	2.09	12.91	....	15.00	....	13.31	......
4037	.....	....	4.00	....	.26	15.25	....	15.51	....	14.73	......
4263	.92	½	1.64	2	1.55	9.39	8	10.94	9	14.41	12.30
4413	1.43	1	2.03	2	2.31	8.32	8	10.63	9	15.56	13.40
4369	.....	....	.....	....	.91	14.48	14	15.39	14½	10.14	9.80

Table of Analysis and Valuation of Fertilizers Made at the

No.	Name and Address of Manufacturer.	Name of Fertilizer.	Place of Sampling.
4401	Maryland Fertilizer Co., Baltimore, Md.	Globe Complete Manure.	Smithsburg.........
4402	“ “ “	Sangston's Cereal and Plant Food.	Smithsburg.........
4494	Wm McKenney, Centreville, Md.	McKenney's Compound.	Centreville ....
4445	F. Mehring, Bruceville, Md.	Acid Phosphate.........	York Road ....
4446	“ “ “	Dissolved Raw Bone....	York Road..........
4447	“ “ “	Twenty-six Dollar Phosphate.	York Road..........
4368	Miller Fertilizer Co., Baltimore, Md.	Buyer's Mixture.........	Baltimore...........
4484	“ “ “	Clinch Phosphate.......	Baltimore.... ......
4372	“ “ “	Dissolved Raw Bone....	Baltimore....... ...
4458	“ “ “	Dissolved Raw Bone....	Ellicott City .. ....
4343	“ “ “	Ground Bone............	Baltimore...........
4345	“ “ “	Ground Bone............	Baltimore...........
4337	“ “ “	Harvest Queen...... ...	Baltimore...........
4354	“ “ “	Hustler Phosphate......	Baltimore...........
4338	“ “ “	S. C. Bone..............	Baltimore ....
4366	“ “ “	Special Wheat Grower..	Baltimore...........
4351	“ “ “	Standard Super Phosphate of Lime.	Baltimore ....
4336	“ “ “	W. G. Phosphate........	Baltimore...........
4399	Geo. W. Miller, Baltimore, Md.	Dissolved Bone Phosphate	Loy's..............
4400	“ “ “	Miller's Mixture.........	Loy's..............
4398	“ “ “	Royal Wheat, Corn and Grass Mixture.	Loy's..............
4487	G. R. Mowell, Glencoe, Md.	Dissolved S. C. Rock....	Monkton...........

Maryland Agricultural College, August, 1897, to February, 1898, continued.

No.	NITROGEN Calculated as AMMONIA.		POTASH, K_2O.		PHOSPHORIC ACID.					Comparative Value per Ton Found.	Comparative Value per Ton Guaranteed.
					Insoluble Found.	Available.		Total.			
	Found.	Guaranteed.	**Found.**	Guaranteed.		**Found.**	Guaranteed.	**Found.**	Guaranteed.		
4401	**2.03**	2	**2.38**	1½	2.96	**8.77**	9	**11.73**	10	**$18.42**	$16.90
4402	**1.32**	1¼	**2.57**	2¼	3.56	**10.00**	10	**13.56**	11	**17.95**	16.40
4494	**2.07**	1½	**1.44**	1¼	2.46	**9.73**	10	**12.19**	....	**18.36**	15.75
4445	....	....	....	....	3.00	**13.37**	14	**16.37**	....	**9.36**	9.80
4446	**1.53**	1½	....	....	1.85	**18.19**	14	**20.04**	....	**23.52**	18.50
4447	**1.52**	1	**1.24**	¾	4.54	**12.77**	11	**17.31**	....	**20.39**	14.75
4368	**.62**	½	**1.02**	1	1.60	**7.84**	7	**9.44**	....	**11.36**	9.50
4484	**1.04**	1	**2.01**	1½	1.76	**9.40**	7	**11.16**	9	**15.23**	12.30
4372	**2.62**	2½	....	....	3.66	**8.82**	11	**12.48**	14	**18.14**	19.70
4458	**2.64**	2½	....	....	4.99	**9.78**	12	**14.87**	15	**19.70**	20.70
4343	**4.03**	4	....	....	....	....	....	**19.13**	16	**26.27**	......
4345	**4.27**	3½	....	....	....	....	....	**22.75**	23	**29.56**	......
4337	**1.38**	1¼	**2.46**	2¼	1.27	**10.47**	10	**11.74**	11½	**17.58**	16.60
4354	**1.36**	1	**2.52**	2¼	1.45	**10.32**	9	**11.77**	10	**17.50**	14.65
4338	....	....	....	....	1.66	**14.88**	14	**16.54**	....	**10.42**	9.80
4366	**2.18**	2	**2.17**	2	1.61	**11.21**	8	**12.82**	10	**20.56**	16.80
4351	**3.49**	2.85	**3.48**	2¼	1.02	**9.03**	10	**10.05**	11½	**23.39**	21.40
4336	**.89**	½	**1.42**	1	1.43	**7.48**	7	**8.91**	8	**12.14**	9.90
4399	....	....	....	....	2.61	**11.87**	14	**14.48**	15	**8.31**	9.80
4400	**2.17**	2	**2.31**	2	5.31	**7.36**	5	**12.67**	12	**18.30**	15.40
4398	**1.18**	1	**2.22**	2	2.68	**9.46**	9	**12.14**	10	**16.29**	14.40
4487	....	....	....	....	2.28	**12.73**	14	**15.01**	15	**8.91**	9.80

Table of Analysis and Valuation of Fertilizers Made at the

No.	Name and address of Manufacturer.	Name of Fertilizer.	Place of Sampling.
4034	G. R. Mowell, Glencoe Md.	Standard Bone Phosphate.	Glencoe...........
4488	" " "	Standard Bone Phosphate.	Glencoe...........
4503	Nickerson Fertilizer Co., Easton, Md	Special Mixture.........	Easton ....
4375	G. Ober & Sons Co., Baltimore, Md.	Dissolved Bone Phosphate.	Hampstead........
4394	" " "	Dissolved Bone Phosphate and Potash.	Union Bridge......
4389	" " "	Farmer's Mixture.......	New Windsor......
4477	" " "	Farmer's Standard Ammoniated Phosphate.	Baltimore.. ....
4434	" " "	J. H. Gassaway's Ammoniated Dis. Bone.	Germantown ......
4459	" " "	Linthicum's Special Mixture.	Ellicott City.......
4492	Patapsco Guano Co., Baltimore, Md.	Baltimore Soluble Phosphate.	Cockeysville ......
4489	" " "	Coon Brand Guano.....	Cockeysville .. ...
4491	" " "	Grain & Grass Producer.	Cockeysville ......
4346	" " "	Pure Dissolved S. C. Bone.	Baltimore ....
4490	" " "	Special Wheat Compound—Ani. Bone Base.	Cockeysville ......
4362	J. Douglas Perkins, Coatsville, Pa.	Monarch H G. Pure Bone and Potash.	Baltimore ....
*4499	Piedmont-Mt. Airy Guano Co., Baltimore, Md.	Caroline Mixture for all Crops.	Greensboro ....
4350	" " "	Mt. Airy S. C. Bone Phosphate.	Baltimore ....
4422	" " "	Piedmont Dissolved Animal Bone.	Baltimore . ...
4423	" " "	Piedmont Dis. Bone Phosphate Potash Goods.	Baltimore ....
4476	" " "	Piedmont Guano for Wheat.	Baltimore ....
4421	" " "	Piedmont No. 1 Raw Bone Meal.	Baltimore..........
4419	" " "	Piedmont Pure Raw Bone Mixture.	Baltimore ....

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*In Bulletin No. 49 the "comparative value found" was given as $14.59, when it should have been $16.59 with the schedule of valuations then in use. The "comparative value guaranteed" was $15.20.

Maryland Agricultural College, August, 1897, to January, 1898, continued.

No.	NITROGEN Calculated as AMMONIA.		POTASH, K_2O.		PHOSPHORIC ACID.					Comparative Value per Ton Found.	Comparative Value per Ton Guaranteed.
					Insoluble Found.	Available		Total.			
	Found.	Guaranteed.	Found.	Guaranteed.		Found.	Guaranteed.	Found.	Guaranteed.		
4034	2.01	2	2.35	2	3.24	11.01	10	14.25	11	$20.67	$18.40
4488	1.82	2	2.23	2	2.65	9.86	10	12.51	11	18.61	18.40
4503	.68	½	2.45	3	1.93	8.41	9	10.34	10	13.67	13.90
4375	.....	....	.....	....	.89	15.76	14	16.65	16	11.03	9.80
4394	.....	....	2.48	2	.50	12.66	11	13.16	13½	11.44	10.20
4389	1.51	1	2.04	2	1.22	11.53	9	12.75	11	18.59	14.80
4477	2.39	2	2.56	2	3 29	8.58	8	11.87	10½	19.63	17.00
4434	2.84	2½	3.28	3	1.80	10.14	9	11.94	11	22.66	20.30
4459	1.56	1	2.12	2	.99	11.15	9	12.14	10½	18.35	14.60
4492	....	....	1.89	2	.95	11.54	11	12.49	12	10.16	9.90
4489	1.12	1	3.09	3	1 36	9.27	9	10.63	10	16.26	15.40
4491	1.33	1¼	2.36	2	.99	10.58	10	11.57	12	17.33	16.55
4346	....	......	......	....	1.05	14.43	14	15.48	15	10.10	9.80
4490	2.39	2½	2.60	2½	2.70	10.90	9	13.60	14	21.75	21.00
4362	1.01	1	5.43	7	1.31	10.82	10	12.13	....	19.80	20.00
4499	1.04	1	2.02	2	1.40	8.17	8	9.57	9	13.87	13.40
4350	.....	....	.....	....	1.55	14.47	13	16.02	14	10.13	9.10
4422	2.76	2½	.....	....	2.80	10.88	11	13.68	15	20.28	20.10
4423	.....	......	.33	1	1.39	11.35	10½	12.74	11½	8.64	8 55
4476	2.11	2	1.45	1	1.99	8.61	8	10.60	10	17.19	15.80
4421	4.12	3½	.....	....	.....	.....	....	17.23	18¼	24.27	.....
4419	1.61	1	1.15	1	3.32	8.57	7	11.89	11	15.88	12.60

Table of Analysis and Valuation of Fertilizers Made at the

No.	Name and Address of Manufacturer.	Name of Fertilizer.	Place of Sampling.
4373	Piedmont-Mt Airy Guano Co., Baltimore, Md.	Piedmont Royal Ammon. Bone and Potash.	Baltimore...........
3612	W. A. Pleasants, Baltimore, Md.	Dorsey's Tobacco Fertilizer.	Baltimore...........
4482	“ “ “	H. G. Wheat Fertilizer.	Baltimore...........
4472	“ “ “	Wheat Food............	Baltimore...........
4367	R. H. Pollock, Baltimore, Md.	Ammoniated Bone Phosphate.	Baltimore...........
4370	“ “ “	Dissolved S. C. Bone....	Baltimore...........
4481	“ “ “	Soft Ground Bone.......	Baltimore...........
4347	“ “ “	Special Wheat Grower..	Baltimore...........
4348	“ “ “	Victor Bone Phosphate..	Baltimore...........
4516	F. E. Postley, Smyrna, Del,	Dissolved S. C. Rock....	Greensboro ....
4517	“ “ “	L. & P. Phosphate......	Greensboro.........
4493	Powell Fert. and Chemical Co., Baltimore, Md.	Red Bag................	Baltimore...........
4436	Ramsburg Fertilizer Co.. Frederick, Md.	Alkaline Phospho-Potassium.	Germantown........
4040	“ “ “	Bone and Potash........	Plane No. 4.........
4426	“ “ “	Dissolved Animal Bone.	Silver Springs......
4427	“ “ “	Dissolved Bone Super Phosphate.	Silver Springs......
3624	“ “ “	Dissolved Bone Super Phosphate.	Kemptown..........
4435	“ “ “	Excelsior Half and Half	Germantown........
4437	“ “ “	Excelsior Plant Food....	Germantown........
4443	“ “ “	Old Virginia Compound.	Middletown.... ....
4428	“ “ “	Pure Bone Meal.........	Silver Springs......
4453	Rasin Fertilizer Co., Baltimore, Md.	Acid Phosphate.........	Hood's Mills........
4495	“ “ “	Ammoniated SuperPhosphate.	Millington ....

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No	NITROGEN Calculated as AMMONIA.		POTASH, K_2O.		PHOSPHORIC ACID.					Comparative Value per Ton Found.	Comparative Value per Ton Guaranteed.
						Available.		Total.			
	Found.	Guaranteed.	**Found.**	Guaranteed.	Insoluble Found.	**Found.**	Guaranteed.	**Found.**	Guaranteed.		
4373	1.50	1.30	2.47	3	1 10	7.40	6	8.50	8	$14.81	$13.70
3612	5.58	......	4.24	....	5.31	6.64	....	11.95	....	29.74	.....
4482	2.06	2	4.08	4	1 38	8.69	8	10.07	....	19.50	18.00
4472	1.04	1	1.85	2	1.54	7.77	8	9.31	....	13.36	13.00
4367	2.19	2	2.02	2	1.35	9.38	10	10.73	11	18.51	18.40
4370	....	....	..	....	.55	15.82	14	16.37	16	11.07	9.80
4481	3.54	3	....	....	8.90	7.68	....	16.58	14	21.86	23.00
4347	1.06	1	2.33	2	1.50	10.54	9	12.04	10	16.65	14.40
4348	.....	.....	1.19	1	.44	10.78	9	11.22	10	8.83	7.50
4516	....	.....	.....	......	.55	13.88	....	14.43	....	9.72	.....
4517	1.17	1	1.15	1	1.46	8.28	7	9.74	....	13.52	11.00
4493	1.50	2	1.25	2	2.40	9.54	8	11.94	10	16.25	16.80
4436	.92	30	1.51	2	3.06	11.08	10	14.14	....	16.57	12.90
4040	....	....	2.12	3	1.45	13.88	12	15.33	....	12.14	11.40
4426	2.05	2	.....	....	5.99	12.92	10	18.91	13	21.47	17.20
4427	....	......	.....	....	.99	14.73	14	15.72	16	10.31	9.80
3624	....	......	.....	....	.60	18.94	14	19.54	....	13.27	9.80
4435	1.44	1	1.37	1	3.56	11.18	10	14.74	12	18.29	14.80
4437	2.77	2	1.08	1	3.94	11.36	9	15.30	11	22.33	16.80
4443	1.78	1½	1.90	2.10	4 06	9.64	9.36	13.70	11.56	18.50	16.84
4428	2.98	3½	.....	....	.....	....	....	28.08	23	33.82	.....
4453	.....	......	.....	....	.37	14.09	14	14.46	15	9.86	9.80
4495	1.00	1	1.25	2	1.11	11.02	8	12.13	9	15.71	13.40

Table of Analysis and Valuation of Fertilizers Made at the

No.	Name and Address of Manufacturer.	Name of Fertilizer.	Place of Sampling.
4478	Rasin Fertilizer Co., Baltimore, Md.	Bone and Potash Fertilizer.	Baltimore
4431	" " "	Dissolved Bone	Gaithersburg
4479	" " "	Empire Guano	Baltimore
4526	Henry Reckord Mfg. Co., Belair, Md.	Dissolved S. C. Bone	Belair
4527	" " "	Fine Ground Bone	Belair
4425	" " "	Raw Bone	Baltimore
4349	" " "	Special Compound	Baltimore
4464	J. S. Reese & Co., Baltimore. Md.	Dissolved Phosphate of Lime.	Elkton
4448	Reindollar & Co., Taneytown, Md.	Fish Phosphate	Taneytown
4449	" " "	Special Mixture	Taneytown
4392	Rinehart & Clemson, Union Bridge, Md.	No. 2 Bone Phosphate	Union Bridge
4393	" " "	No. 3 Bone Phosphate	Union Bridge
4342	Isaac Robinson, Baltimore, Md.	H. G. Soluble Phosphate	Baltimore
4340	" " "	Peerless Phosphate	Baltimore
4424	" " "	Potashed Bone	Baltimore
4365	" " "	Pure Bone Meal	Baltimore
4480	" " "	Pure Dissolved Bone	Baltimore
4344	" " "	Pure Dis. Raw Bone	Baltimore
4352	" " "	Pure Raw Bone	Baltimore
4339	" " "	Special Wheat and Grass Phosphate.	Baltimore
4341	" " "	Standard Dissolved Bone Phosphate.	Baltimore
4511	E. C. Ross, Seaford, Del.	H. G. Acid Phosphate	Aireys
4505	" " "	H. G. Wheat Phosphate.	Princess Anne

Maryland Agricultural College, August, 1897, to January, 1898, continued.

No.	NITROGEN Calculated as AMMONIA.		POTASH, K_2O.		PHOSPHORIC ACID.					**Comparative Value per Ton Found.**	Comparative Value per Ton Guaranteed.
					Insoluble Found.	Available.		Total.			
	Found.	Guaranteed.	**Found.**	Guaranteed.		**Found.**	Guaranteed.	**Found.**	Guaranteed.		
4478	....	....	**1.29**	1¼	2.70	**12.00**	12	**14.70**	13	**$10.23**	9.85
4431	**2.58**	2	....	....	3.04	**10.54**	10	**13.58**	12	**19.50**	16.80
4479	**2.52**	2.43	**1.69**	1½	2.86	**8.84**	8	**11.70**	10	**19.23**	17.59
4526	....	....	....	....	2.43	**13.26**	14	**15.69**	....	**9.28**	9.80
4527	**3.99**	3	....	....	....	....	....	**25.34**	25	**31.64**	......
4425	**4.82**	5.29	....	....	....	....	....	**20.14**	20.38	**25.25**	......
4349	**2.06**	2.03	**2.15**	2.13	1.85	**10.34**	10.66	**12.19**	13.18	**19.41**	19.89
4464	....	....	....	....	.61	**15.73**	14	**16.34**	16	**11.01**	9.80
4448	**2.35**	2	**2.44**	2	.80	**9.26**	8	**10.06**	....	**19.07**	16.00
4449	**1.45**	1	**1.57**	1	.80	**9.18**	7	**9.98**	....	**15.42**	11.00
4392	**2.06**	1.55	**2.95**	2½	2.27	**8.97**	8.27	**11.24**	....	**19.01**	15.42
4393	**1.59**	.76	**2.24**	3.21	1 93	**9.94**	8.09	**11.87**	....	**17.72**	13.58
4342	....	....	....	....	1.07	**14.59**	14	**15.66**	....	**10.21**	9.80
4340	**.56**	½	**1.54**	1½	2.38	**7.79**	8	**10.17**	10	**11.96**	11.80
4424	....	....	**1.76**	2	2.40	**10.36**	10	**12.76**	12	**9.49**	9.40
4365	**4.89**	4	....	....	....	....	....	**22.32**	20	**28.18**	......
4480	**2.62**	2½	....	....	3.55	**9.63**	11	**13.18**	14	**18.91**	19.70
4344	**2.64**	2½	....	....	5.70	**9.58**	11	**15.28**	14	**19.78**	19.70
4352	**4.66**	4	....	....	....	....	....	**22.86**	23	**28.74**	......
4339	**2.11**	2	**2.34**	2	1.65	**8.11**	8½	**9.76**	11	**17.44**	17.50
4341	**1.02**	1	**2.03**	2	1.20	**10.18**	10	**11.38**	11½	**15.75**	15.60
4511	....	....	....	....	3.73	**11.62**	13	**15.35**	....	**8.13**	9.10
4505	**.93**	2	**1.20**	2	4.67	**9.70**	10	**14.37**	....	**15.56**	18.00

Table of Analysis and Valuation of Fertilizers Made at the

No.	Name and Address of Manufacturer.	Name of Fertilizer.	Place of Sampling
4504	E. C. Ross, Seaford, Del..	Soluble Bone Phosphate, or Rock and Potash.	Princess Anne......
4384	Charles Schaeffer, Westminster, Md.	Big Gun.................	Westminster........
4388	“ “ “	Dissolved S. C. Bone....	Westminster........
4386	“ “ “	Governor................	Westminster........
4387	“ “ “	Leader..................	Westminster........
4385	“ “ “	Pure Raw Bone Meal....	Westminster........
4383	“ “ “	Super “A”.............	Westminster........
4522	Scott Fertilizer Co., Elkton, Md.	Elk Head Phosphate....	Rising Sun..........
4471	“ “ “	Pure Dissolved Bone....	Elkton..............
4531	“ “ “	Pure Ground Bone......	Aberdeen ....
4523	“ “ “	Sure Growth Super Phosphate.	Rising Sun..........
4467	“ “ “	Tip Top Soluble Bone...	Elkton ....
4524	“ “ “	Tip Top Soluble Bone and Potash.	Rising Sun..........
4532	Sharpless & Carpenter, Philadelphia, Pa.	Dissolved Bone Phosphate.	Aberdeen...........
4530	“ “ “	No. 1 Bone Phosphate...	Aberdeen...........
4420	D. A. Sharretts, York Road, Md.	Ammoniated SuperPhosphate.	Baltimore...........
4485	G. W. Sharretts & Co., Baltimore, Md.	Ammoniated Bone......	Baltimore...........
4486	“ “ “	Fish Rock and Potash...	Baltimore...........
4414	J. D. Simmons, Hagerstown, Md.	Wheat and Clover Producer Animal Bone.	Hagerstown........
4483	Slingluff & Co., Baltimore, Md.	Agencey Favorite H. O. D.	Baltimore...........
4457	“ “ “	Alkaline Super Phosphate.	Sykesville..........
4462	“ “ “	Ammoniated Bone	Ellicott City........
4455	“ “ “	Ammoniated SuperPhosphate.	Sykesville..........

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No.	NITROGEN Calculated as AMMONIA.		POTASH, K_2O.		PHOSPHORIC ACID.					Comparative Value per Ton Found.	Comparative Value per Ton Guaranteed.
					Insoluble Found.	Available.		Total.			
	Found.	Guaranteed.	**Found.**	Guaranteed.		**Found.**	Guaranteed.	**Found.**	Guaranteed.		
4504	....	....	1.08	1½	2.29	11.15	10	13.44	11	$ 9.35	$ 8.70
4384	1.84	2	2.08	2	1.16	10.88	10	12.04	....	18.94	18.00
4388	.....	...	.....	....	.92	15.48	14	16.40	15	10.84	9.80
4386	1.57	1½	2.52	2½	.73	9.96	9	10.69	... .	17.48	16.00
4387	1.20	1	1.81	1½	1.43	8.95	8	10.38	....	14.93	12.50
4385	4.83	4	.....	....	....	....	....	22.35	22	28.41	......
4383	.85	¾	1.35	1	1.16	8.25	7½	9 41	8½	12.61	11.15
4522	1.20	1	1.15	1	1.33	10.74	8	12.07	10	16.02	12 80
4471	2.51	2½	.....	....	3.26	13.95	13	17.21	15	22.78	21.30
4531	5.06	4	.....	....	.....	.....	....	23.46	22	27.28	......
4523	2.51	2	2.10	2	2.84	10.32	9	13.16	11	21.09	17.80
4467	....	....	.....	....	.79	15.09	14	15.88	....	10.56	9 80
4524	.....	....	1.81	2	1.73	12.67	11	14.40	....	11.03	9.70
4532	2.76	3	4.61	5	3.66	9.36	8	13.02	....	23.83	22.00
4530	2.38	2½	2.05	2	2.01	9.05	8½	11.06	....	19.04	18.00
4420	1.30	1	1.30	1	.90	11.09	9	11.99	....	16.65	13.00
4485	.65	½	1.23	1	1.03	5.28	5	6.31	6	8.87	7.90
4486	.34	¼	1.04	½	.85	4.87	5	5.72	6	7.31	6.65
4414	1.48	2	6.79	6	5.70	10.56	12	16.26	....	24.23	24.00
4483	2.88	....	2.17	....	3.54	11.50	....	15.04	....	23.73	......
4457	.....	....	1.76	4	.63	10.61	10	11.24	....	9.32	11.00
4462	2.52	2½	2.21	2½	2.04	10.45	9	12.49	....	21.04	19.00
4455	1.57	1	1.87	1	2.01	11.13	8	13.14	....	18.51	12.20

Table of Analysis and Valuation of Fertilizers Made at the

No	Name and Address of Manufacturer.	Name of Fertilizer.	Place of Sampling.
4417	Slingluff & Co., Baltimore, Md.	Baltimore Dissolved Bone.	Baltimore...........
4500	" " "	Bone and Potash........	Dover Bridge.......
4052	" " "	South Carolina & Potash	Easton.. ....
4418	" " "	Dissolved S. C. Bone ..	Baltimore...........
4463	" " "	Half and Half..........	Ellicott City.......
4456	" " "	Pure Raw Bone, Dissolved.	Sykesville.........
4416	" " "	Special Bone Phosphate.	Baltimore..........
4433	" " "	Universal Guano........	Gaithersburg........
4396	G. W. Stockdale, Thurmont, Md.	Ammoniated SuperPhosphate	Thurmont..........
4395	" " "	Dissolved Animal Bone Phosphate.	Thurmont ....
4407	J. W. Stonebraker & Son Hagerstown, Md.	Bone Meal..............	Hagerstown ....
4403	" " "	Dissolved Animal Bone.	Hagerstown ....
4404	" " "	Dissolved Bone Phosphate.	Hagerstown........
4406	" " "	Special..................	Hagerstown ....
4405	" " "	Standard Dissolved Bone	Hagerstown ....
4391	J. A. Stouffer, New Windsor, Md.	Butcher House Phosphate.	New Windsor.......
4390	" " "	Wheat Grower..........	New Windsor.......
4353	Wm. H. Streett & Co., Baltimore, Md.	Ammoniated Dissolved Bone.	Baltimore...........
3619	" " "	Ammoniated Dissolved Bone.	Glencoe...........
4358	" " "	Ground Bone...........	Baltimore...........
3623	" " "	Ground Bone...........	Shane ....
4364	" " "	S. C. Bone..............	Baltimore....... ...
4451	J. W. Sullivan, Monrovia, Md.	Sullivan's Sure Success.	Monrovia..........

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No	NITROGEN Calculated as AMMONIA.		POTASH. K_2O.		PHOSPHORIC ACID.					**Comparative Value per Ton Found.**	Comparative Value per Ton Guaranteed.
						Available.		Total.			
	Found.	Guaranteed.	**Found.**	Guaranteed.	Insoluble Found.	**Found.**	Guaranteed.	**Found.**	Guaranteed.		
4417	.95	1	.44	1	2.14	12.03	10	14.17	....	$16.17	$14.00
4500	....	....	1.65	2	.67	11.30	10	11.97	11	9.69	9.20
4052	....	....	1.77	....	.70	11.47	....	12.17	....	9.93	......
4418	....	....	....	....	.80	15.89	14	16.69	....	11.12	9.80
4463	2.01	1¾	....	....	9.44	8.52	8	18.46	....	18.51	13.25
4456	2.73	2½	....	....	2.15	13.45	11	15.60	14	22.50	19.70
4416	1.15	1	....	....	1.35	13.15	12	14.50	13	17.14	15.40
4433	1.19	1	1.73	2	1.48	11.00	9	12.48	....	16.89	14.00
4396	1.05	1	2.71	2½	1.66	9.36	9	11.02	....	15.88	14 50
4395	1.31	1½	2.64	2¼	1.80	9.07	8	10.87	....	16.36	14.75
4407	4.88	4½	....	....	....	....	....	20.35	21	29.26	......
4403	2.58	2½	....	....	3.04	13.30	12	16.34	....	22.25	19.50
4404	1.05	1	2.26	2	1.31	9.29	10	10.60	13	15.22	16.20
4406	2.34	2½	4.04	4	3.53	10.50	9	14.03	13½	22.97	22.30
4405	3.10	2	....	....	10.39	8.52	10	18.91	14	21.98	17.60
4391	.99	¾	3.91	3	1.48	9.26	8	10.74	9	16.73	13.15
4390	.70	¾	2.54	2½	1.34	10.12	7½	11.46	9½	15.30	13.05
4353	1.66	1½	2.29	2	1.65	9.89	9	11.54	10	17.82	15.90
3619	2.06	½	2.33	2	1.70	9.95	9	11.65	....	19.04	13.50
4358	4.73	4	....	....	.....	....	....	22.42	17	31.87	.....
3623	5.04	4	....	....	.....	.....	....	23.14	17	32.22	......
4364	....	... .	....	....	1.40	14.86	14	16.26	16	10.40	9.80
4451	1.82	2	2.07	2	3.55	10.63	10	14.18	....	19.58	18.00

Table of Analysis and Valuation of Fertilizers Made at the

No.	Name and Address of Manufacturer.	Name of Fertilizer.	Place of Sampling.
4454	Susquehanna Fertilizing Co., Baltimore, Md.	Ammoniated Bone Phosphate.	Hood's Mills.......
4378	“ “ “	Alkaline Bone Phosphate.	Hampstead.........
4496	“ “ “	Crop Grower...........	Chestertown........
4355	“ “ “	Pure Bone Phosphate....	Baltimore...........
4452	“ “ “	Superior Rock Phosphate	Mt. Airy............
4050	“ “ “	Superior Rock Phosphate	Crumpton ....
4438	“ “ “	XXV Phosphate........	Germantown........
4430	R. B. Tenney, Georgetown, D. C.	Pure Ground Bone Dust.	Gaithersburg........
4411	D. A. Thomas, Hagerstown, Md.	Bone Mixture..........	Hagerstown ....
4408	“ “ “	Dissolved Bone.........	Hagerstown ....
4409	“ “ “	Farmer's Mixture.......	Hagerstown ....
4410	“ “ “	Fine Raw Bone..	Hagerstown ....
4412	“ “ “	S. C. Bone...	Hagerstown ....
4497	I. P. Thomas & Son Co., Philadelphia, Pa.	Normal Bone Phosphate.	Price's Station......
4415	“ “ “	S. C. Phosphate.........	Hancock............
4507	W. B. Tilghman Co., Salisbury, Md.	Bone and Tankage Mixture for Wheat & Grass.	Salisbury...........
4509	“ “ “	Fish Mixture...........	Salisbury...........
4508	“ “ “	Mixture “B”..	Salisbury..........
4506	E. S. Truitt, Salisbury, Md.	Fish Mixture XX........	Salisbury . ...
4498	J. E. Tygert Co., Philadelphia, Pa.	Popular Phosphate......	Greensboro ....
4439	J. Tyson & Sons, Frederick, Md.	Ammoniated SuperPhosphate of Lime.	Barnesville.........
4441	“ “ “	Half and Half Super-Phosphate.	Frederick. ....
4048	“ “ “	Half and Half..........	Park Mills... ......

Maryland Agricultural College, August, 1897, to February, 1898, continued.

No.	NITROGEN Calculated as AMMONIA.		POTASH, K_2O.		PHOSPHORIC ACID.					Comparative Value per Ton Found.	Comparative Value per Ton Guaranteed.
					Insoluble Found.	Available.		Total.			
	Found.	Guaranteed.	**Found.**	Guaranteed.		**Found.**	Guaranteed.	**Found.**	Guaranteed.		
4454	2.38	2	2.18	2	2.91	10.47	9	13.38	11	$20.95	$17.80
4378	....	....	2.23	2	1.13	10.53	10	11.66	12	9.83	9.40
4496	1.17	1	1.12	1	3.55	8.25	8	11.80	10	14.30	12.80
4355	2.21	2	2.60	2	6.00	10.41	9	16.41	11	22.04	17.80
4452	....	....	....	....	1.07	14.98	14	16.05	15	10.49	9.80
4050	....	....	....	....	.91	16.52	14	17.43	....	11.55	9.80
4438	1.45	1¼	1.22	1	1.43	9.60	8	11.03	10	15.74	13.55
4430	4.74	....	....	....	...	....	....	19.75	....	24.11	.....
4411	2.31	2	3.26	2	1.99	9.74	10	11.73	....	20.73	18.00
4408	3.63	3	....	....	3.75	14.94	11	18.69	15	27.33	21.60
4409	1.55	1½	1.86	1½	1.93	9.12	8	11.05	....	16.40	14.00
4410	4.53	4	....	....	.....	. ...	....	22.95	20½	31.35	......
4412	....	....	....	....	.87	15.39	14	16.26	....	10.77	9.80
4497	.91	1¼	3.32	1½	2.63	8.40	8½	11.03	9½	15.50	14 15
4415	....	....	....	....	.44	16.62	14	17.06	16	11.63	9.80
4507	3.07	3	2.21	1	2.85	8.64	8	11.49	....	21.20	18.00
4509	3.29	3½	1.21	1	1.84	8.52	6	10.36	....	20.34	17.50
4508	3.98	3½	1.45	2	2.86	7.69	8	10.55	....	22.22	20.50
4506	2.81	3	2.08	2	1.45	8.39	8	9 84	10	19.48	19.80
4498	1.01	1	1.25	1	1.51	6.93	7	8.44	8	11.81	11.60
4439	1.53	2	1.98	1	2.23	10.62	7	12.85	... .	18.08	14.00
4441	.81	½	.14	1	1.79	11.71	8	13.50	....	14.86	10.50
4048	.88	2	.16	1	2.34	11.10	7	13.44	....	14.84	14.00

Table of Analysis and Valuation of Fertilizers Made at the

No.	Name and Address of Manufacturer.	Name of Fertilizer.	Place of Sampling
4049	J. Tyson & Son, Frederick, Md.	South Carolina.........	Park Mills..........
4442	" " "	Special Mixture........	Frederick...........
4429	Virginia-Carolina Chemical Co., Richmond, Va.	Guaranteed 14% Acid Phosphate.	Rockville...........
4432	" " "	Guaranteed 13% Acid Phosphate.	Gaithersburg........
4440	" " "	Special Compound for Wheat.	Walkersville........
4377	Joshua Walker, Baltimore, Md.	Old Pittsburg Am. Bone Bone Super Phosphate	Hampstead...... ..
4376	" " "	Victor Bone...........	Hampstead.... ....
4510	S L. Webster & Son Cambridge, Md.	Acidulated Bone.......	Secretary...........
4046	" " '	Acidulated Bone.......	Easton.............
4512	" " "	No. 2 Ammoniated Bone Phosphate.	Cambridge..........
4513	" " "	Poudrette Mixture.....	Cambridge..........
4514	" " "	The Times Bone Phosphate.	Cambridge. ....
4465	M. E. Wheeler & Co, Rutland, Vt.	Electrical Dis. Bone....	Elkton.............
4450	" " "	Royal Wheat Grower....	Monrovia...... ....
4519	Williams & Clark Fertilizer Co., New York.	Acorn Brand Acid Phosphate.	Ridgely...... .....
4520	" " "	Americus Brand Pure Bone Meal.	Ridgely.............
4521	" " "	Dissolved Animal Bone	Ridgely.............
4518	" " "	Dissolved Bone and Potash.	Greensboro.........
4474	" " "	Special Wheat Grower.	Baltimore ....
4359	Robt. A. Wooldridge Co. Baltimore, Md.	Chieftain................	Baltimore...........
4466	" " "	Bone and Potash Mixture.	Ellicott City........
4361	" " "	Little Giant............	Baltimore ....
4473	" " "	Pure Raw Bone.........	Baltimore..........

Maryland Agricultural College, August, 1897, to February, 1898, continued.

No.	NITROGEN Calculated as AMMONIA.		POTASH, K_2O.		PHOSPHORIC ACID.					**Comparative Value per Ton Found.**	Comparative Value per Ton, Guaranteed.
					Insoluble Found.	Available.		Total.			
	Found.	Guaranteed.	**Found.**	Guaranteed.		**Found.**	Guaranteed.	**Found.**	Guaranteed.		
4049	....	....	....	....	2.12	**15.06**	14	**17.18**	....	**$10.54**	$ 9.80
4442	**1.02**	1	**.74**	1	1.33	**11.20**	8	**12.53**	....	**15.53**	12.00
4429	....	....	....	....	1.77	**14.83**	14	**16.60**	15	**10.38**	9.80
4432	....	....	....	....	1.82	**13.62**	12	**15.44**	13	**9.53**	8.40
4440	**1.26**	1	**1.25**	1	2 65	**9.07**	8	**11.72**	....	**15.16**	12.00
4377	**2.60**	2.43	**1.75**	1½	3.04	**8.62**	8	**11.66**	10	**19.38**	17.59
4376	....	....	**1.59**	1½	1.37	**11.33**	12	**12.70**	13	**9.79**	10.10
4510	....	....	....	....	2.33	**7.93**	13.90	**10.26**	14.43	**5.55**	9.73
4046	....	....	....	....	.90	**14.48**	13.90	**15.38**	14.43	**10.14**	9.73
4512	**2.04**	2½	**2.38**	2	2.75	**6.70**	7	**9.45**	9.05	**16.30**	15.32
4513	**.53**	.51	**2.16**	3.01	1.24	**5.63**	6½	**6.83**	7.68	**9.86**	11.49
4514	**.58**	½	**2.48**	3	1.54	**6.20**	9	**7.74**	9.65	**11.04**	13.76
4465	....	....	...	....	.63	**15.68**	13	**16.31**	15	**10.98**	9.10
4450	**1.03**	1	**1.70**	2	2.34	**7.05**	8	**9.39**	9	**12.78**	13.40
4519	....	....	....	......	2.46	**14.54**	13	**17.00**	14	**10.18**	9.10
4520	**5.16**	3	....	......	......	....	....	**18.25**	20	**27.95**	......
4521	**2.59**	2½	...	....	3.31	**11.17**	10	**14.48**	......	**20.26**	17.50
4518	....	......	**2.02**	2	3 81	**10.01**	10	**13.82**	11	**9.79**	9.20
4474	**1.48**	1	**2.02**	2	1.91	**9.24**	8	**11.15**	......	**16.46**	13.00
4359	**2.02**	2	**2.14**	1½	1.95	**10.18**	9	**12.13**	10	**19.16**	16.90
4460	....	....	**1.82**	2	1.07	**11.72**	11	**12.79**	12	**10.2**	9.90
4361	**1.01**	1	**2.59**	2	1.46	**10.46**	9	**11.92**	10	**16.60**	14.40
4473	**4.59**	4½	....	....	......	....	....	**20.13**	20½	**26.87**	.....

Table of Analysis and Valuation of Fertilizers Made at the

No.	Name and Address of Manufacturer.	Name of Fertilizer.	Place of Sampling.
4461	Robt. A Wooldridge Co., Baltimore, Md.	Triumph Pure Bone Phosphate.	Ellicott City........
4380	Zell Guano Co., Baltimore, Md.	Calvert Guano..........	Westminster........
4381	" " "	Dissolved Bone Phosphate.	Westminster........
4379	" " "	Dissolved Bone Phosphate and Potash.	Westminster........
4382	" " "	Economizer............	Westminster........
4051	" " "	Dissolved Bone Phosphate	Crumpton..........

NOTE.—In Bulletin No. 49 the "comparative value found of Zell's Dissolved Bone Phosphate," sample No. 3913, was printed $10.08, when it should have been $15 08. The "comparative value guaranteed was $14 00. These values are calculated by the old schedule as used in Bulletin No. 49. By the present schedule they would be considerably lower.

Maryland Agricultural College, August, 1897, to January, 1898, continued.

No.	NITROGEN Calculated as AMMONIA.		POTASH, K_2O.		PHOSPHORIC ACID.					**Comparative Value per Ton Found.**	Comparative Value per Ton Guaranteed.
						Available.		Total.			
	Found.	Guaranteed.	**Found.**	Guaranteed.	Insoluble Found.	**Found.**	Guaranteed.	**Found.**	Guaranteed.		
4461	1.54	1½	3.79	4	1.36	9.30	8	10.66	9	$18.25	$16.90
4380	1.00	¾	1.67	1½	2.40	10.11	9	12.51	11	15.74	13.55
4381	...	....	.....	....	1.71	14.79	14	16.50	16	10.35	9.80
4379	....	....	.60	1	2.01	13.12	12	15.13	14	10.18	9.80
4382	1.19	1	1.19	1	1.35	11.05	9	12.40	11	16.35	13.80
4051	....	.... ..	.....	....	2 03	15.51	14	17.54	....	10.85	9.80

Bulletin No. 52, February, 1898.

Table Showing the Mechanical Analysis of Ground Bone.

(*The Chemical Analysis is Given in Preceding Table.*)

No.	Name And Address of Manufacturer.	Name of Fertilizer.	Fine Less than 1-50 inch.	Fine-Medium, 1-25 to 1-50 inch.	Medium, 1-25 to 1-12 inch.	Coarse Larger than 1-12 inch.
4181	Alexandria Fertilizer and Chemical Co., Alexandria, Va.	Pure Raw Bone Meal..........	40	42	18	00
4107	Baugh & Sons Co., Baltimore. Md.	Bone Meal, Warranted Pure...	46	35	19	00
4238	The Berg Co., Philadelphia, Pa	Raw Bone Fine...	28	30	29	13
4133	J. Bullock & Son, Baltimore, Md.	Pure Ground Raw Bone.......	41	26	33	00
4299	Chemical Co., of Canton, Baltimore, Md.	Baker's Standard Ground Bone	44	35	21	00
4239	E. A. Clendennin & Bro., Coloro, Md.	Fine Ground Bone.............	15	38	33	14
4291	" " " "	Pure Ground Bone............	16	38	31	15
4124	Ed. L. Coulson, Baltimore, Md.	Pure Fine Ground Bone........	45	21	34	00
4103	Detrick Fertilizer & Chemical Co., Baltimore, Md.	Pure Fine Ground Animal Bone.	40	37	23	00
4281	Eureka Fertilizer Co., Perryville, Md.	Bone Meal........................	62	27	11	00
4106	Griffith & Boyd, Baltimore, Md	Pure Fine Ground Bone Meal..	23	20	57	00
4115	Griffith, Turner & Co., Baltimore, Md.	Strictly Pure Raw Bone Meal..	30	20	50	00
4166	Hanover Bone Fertilizer Co. Hanover, Pa.	Pure Bone Meal........	31	47	22	00
4249	S. M. Hess & Bro., Philadelphia, Pa.	Ground Bone.....................	17	32	41	10
4100	J. Horner, Jr. & Co., Baltimore. Md.	Slaughter House Bone Dust....	37	28	35	00
4221	Hubbard & Co., Baltimore, Md.	Warranted Pure Raw Bone....	22	25	53	00
4213	Lazaretto Guano Co., Baltimore, Md.	Harford Bone..................	35	26	39	00
4235	" " " "	Pure Ground Bone	18	25	57	00
4187	Lister Agricultural Chemical Works, Newark, N. J.	Pure Raw Bone Meal..........	36	33	31	00
4173	Joseph Lister, Chicago, Ill.	Pure Bone Meal................	45	39	16	00
4343	Miller Fertilizer Co., Baltimore, Md.	Ground Bone..................	50	24	26	00
4345	" " " "	Ground Bone.....................	44	30	26	00
4421	Piedmont—Mt. Airy Guano Co., Baltimore, Md.	Piedmont No. 1 Raw Bone Meal	45	22	33	00
4428	Ramsburg Fertilizer Co., Frederick, Md.	Pure Bone Meal................	68	26	6	00
4527	Henry Reckord Mfg. Co., Belair, Md,	Fine Ground Bone.............	50	31	15	4
4425	" " " "	Raw Bone........................	12	36	52	00
4365	Isaac Robinson, Baltimore, Md.	Pure Bone Meal................	24	30	46	00
4352	Isaac Robinson, Baltimore, Md.	Pure Raw Bone.....	31	27	42	00
4385	Chas. Schaeffer, Westminster, Md.	Pure Raw Bone Meal..........	24	36	40	00
4531	Scott Fertilizer Co., Elkton, Md.	Pure Ground Bone............	15	26	49	10
4407	J. W. Stonebraker, Hagerstown, Md.	Bone Meal......................	46	29	25	00

Table Showing Mechanical Analysis of Ground Bone—Continued.

No.	NAME AND ADDRESS OF MANUFACTURER.	NAME OF FERTILIZER.	Fine Less than 1-50 inch.	Fine-Medium 1-25 to 1-50 inch.	Medium 1-25 to 1-12 inch.	Coarse Larger than 1-12 inch.
4358	W. H. Street & Co., Baltimore, Md.	Ground Bone	58	25	17	00
3623	" " "	Ground Bone	46	36	18	00
4430	R. B. Tenney, Georgetown. D.C.	Pure Ground Bone Dust	11	27	62	00
4410	D. A. Thomas, Hagerstown, Md.	Fine Raw Bone	48	37	15	00
4520	Williams & Clark Fertilizer Co., New York.	Americus Brand Pure Bone Meal	41	35	24	00
4473	Robert A. Wooldridge Co., Baltimore, Md.	Pure Raw Bone	30	36	34	00

LIST OF FERTILIZERS LICENSED FOR SALE IN MARYLAND FOR THE YEAR ENDING FEBRUARY 1, 1898.

(Supplement to List Published in Bulletin No. 49, August, 1897.)

ALEXANDRIA FERTILIZER AND CHEMICAL COMPANY, ALEXANDRIA, VA.

- Pure Raw Bone Meal.

BAUGH & SONS CO., BALTIMORE, MD.

- Fish Phosphate.
- Special Mixture.

B. A. BETTS, CHEWSVILLE, MD.

- Jos. Lister's Fine Ground Bone.

A. D. BIRELY & SONS, LADIESBURG, MD.

- No. 1 Ammoniated Bone Phosphate.
- No. 2 Dissolved Bone.

JOHN BULLOCK & SON, BALTIMORE, MD.

- Pure Ground Raw Bone.

HENRY COPE & CO., LINCOLN UNIVERSITY, PA

- Ammoniated Bone Phosphate.
- Potato and Corn Phosphate.

CROCKER FERTILIZER AND CHEMICAL CO., BUFFALO, N. Y.

- High Grade Cereal Guano.

E. E. DE LASHMUTT, FREDERICK, MD.

- Delashmutt's Mixture.

DETRICK FERTILIZER AND CHEMICAL CO., BALTIMORE, MD.

- Alkaline Bone.
- Carroll Mixture.
- Emory's Bone and Potash.
- Fish Mixture.
- P. & B. Special Fertilizer.

J. W. DORSEY, ELLICOTT CITY, MD.

Dorsey's Mixture "D."

DRAPER, DAVIS & CO., MILFORD, DEL.

Jumbo Phosphate.
Rock.
XX Raw Bone Phosphate.

THOS. W. ELIASON, CHESTERTOWN, MD.

Chester Compound.
M. P.
No. 1 Compound.
Our Special.

FARMERS' FERTILIZER CO., WESTMINSTER, MD.

Pure Dissolved Bone.

GRIFFITH, TURNER & CO., BALTIMORE, MD.

Pure Raw Bone Meal.

HUBBARD & CO., BALTIMORE, MD.

Climax Super Phosphate.
Crescent Soluble Crop Producer.
Dissolved Raw Bone.
Warranted Pure Bone.

T. R. HUBBARD & CO., BALTIMORE, MD.

Special Mixture.

M. P. HUBBARD & CO., BALTIMORE, MD.

Celebrated Dissolved Bone Phosphate.
Farmers' Acme.
Farmers' Old Economy.

THOS. C. HUNTER, WHITE HALL, MD.

Ext. Ammoniated Bone Phosphate.

S. L. LAMBERD & CO., BALTIMORE, MD.

S. L. Lamberd & Co. Favorite.

A. A. LECHLIDER, HAGERSTOWN, MD.

Eagle Bone Phosphate.
Soluble Bone.
S. C. Bone.

LISTER'S AGRICULTURAL CHEMICAL WORKS, NEWARK, N. J.

Animal Bone and Potash.
Special Crop Producer.
Special for Wheat and Grass.
Special for Wheat.
Success Fertilizer.

W. A. McKENNEY, CENTREVILLE, MD.

Compound.
No. 1 D Wheat Fertilizer.
Soluble No. 3 Phosphate.

MONUMENTAL CHEMICAL COMPANY, BALTIMORE, MD.

Monumental Acid Phosphate.
Soluble Bone Phosphate and Potash.
Wm. Penn, Crop Grower.

MILLER FERTILIZER COMPANY, BALTIMORE, MD.

Special Wheat Grower.
Ground Bone.
W. G. Phosphate.

OBER & SONS, BALTIMORE, MD.

Hood's Special Mixture.
Gassaway's Ammoniated Dissolved Bone.
Linthicum's Special Mixture.
Sharrett's Standard Dissolved S. C. Rock Phosphate.
Valiant's Ammoniated Wheat Grower.

WM. A. PLEASANTS, BALTIMORE, MD.

H. G. Wheat.
Wheat Food.

PIEDMONT-MT. AIRY GUANO CO., BALTIMORE, MD.

Piedmont No. 1 Raw Bone Meal.
Piedmont Dissolved Animal Bone.

RAMSBURG FERTILIZER CO., BALTIMORE, MD.

Excelsior Half and Half.

ISAAC ROBINSON, BALTIMORE, MD.

Pure Dissolved Raw Bone.
Peerless Phosphate.
Special Wheat and Grass Phosphate.

SCOTT FERTILIZER CO., ELKTON, MD.

Elk Head Super Phosphate.

G. W. SHARRETTS & CO., BALTIMORE, MD.
Sharretts' Climax Fertilizer.

SLINGLUFF & CO., BALTIMORE, MD.
Bone and Potash.

J. W. STONEBRAKER & SON, HAGERSTOWN, MD.
Bone Meal.
Dissolved Animal Bone.
Dissolved Bone Phosphate.
Special.
Standard Dissolved Bone.

JOS. A. STOUFFER, NEW WINDSOR, MD.
Stouffer's Butcher House.
Stouffer's Soluble Wheat Grower.

D. A. THOMAS, HAGERSTOWN, MD.
Bone Mixture.
Dissolved Bone.
Farmers' Mixture.
Fine Raw Bone.
S. C. Bone.

J. E. TYGERT & CO., PHILADELPHIA, PA.
Popular Phosphate.

J. TYSON & SON, FREDERICK, MD.
Tyson's S. C.
Tyson's Special.

E. S. VALIANT & SONS, CHURCH HILL, MD.
High Grade Bone Phosphate.

ROBERT A. WOOLDRIDGE & CO., BALTIMORE, MD.
Pure Raw Bone.

LIST OF BRANDS OF FERTILIZERS LICENSED FOR SALE IN MARYLAND FOR THE YEAR ENDING FEBRUARY 1, 1899

(Corrected to February 18, 1898.)

BALTIMORE GUANO CO., BALTIMORE, MD.
Farmers' Dissolved Bone.
B. G. Ammoniated Bone Phosphate.

THE BERG CO., PHILADELPHIA, PA.
- Berg's $25 Bone Manure.
- Berg's Pure Raw Bone Fine.

JAS. BONDAY, Jr., & CO., BALTIMORE, MD.
- Kainit.
- Muriate of Potash.
- Sulphate of Potash.

BRUMFIELD & FOSTER, COLORA, MD.
- Hard Times Ammoniated Phosphate.

CHEMICAL COMPANY OF CANTON, BALTIMORE, MD.
- Dissolved Animal Bone.
- Soluble Bone and Potash.

CROCKER FERTILIZER AND CHEMICAL CO., BUFFALO, N. Y.
- New Rival Ammoniated Super Phosphate.
- Potato, Hop and Tobacco Phosphate.
- Practical Ammoniated Super Phosphate.

RUFUS K. DAY, BROWNINGSVILLE, MD.
- Ammoniated Bone Phosphate.

DETRICK FERTILIZER AND CHEMICAL CO., BALTIMORE, MD.
- Ammoniated Bone Phosphate.
- Corn Fertilizer.
- Dissolved Bone.
- Dissolved S. C. Bone.
- Farmers' Friend.
- Farmers' New Method Phosphate.
- Fish Mixture.
- Detrick Gold Eagle.
- Imperial Compound.
- Potato Fertilizer.
- Pure Raw Bone.
- Royal Crop Grower.
- Sea Fowl Guano.
- Soluble Bone Phosphate and Potash Fertilizer.
- Special Mixture.
- Standard Potato Fertilizer.
- Vegetator Ammoniated Super Phosphate.
- Wheat Fertilizer.

LOUIS F. DETRICK, BALTIMORE, MD.
- Bone and Potash Mixture.
- Kangaroo Komplete Kompound.
- Sockless and Shoeless Fertilizer.
- Orchilla Guano.
- Silver Gray A. A. Phosphate.
- XXtra Acid Phosphate.

DUDLEY & CARPENTER, BALTIMORE, MD.
California Tobacco Compound.
Dissolved S. C. Bone.
Soluble Bone Phosphate.
Special Tobacco Plant Guano.
Special Wheat Mixture.

DAVID ENGLAR, JR., MEDFORD, MD.
No. 3 Bone Phosphate.

ENGLAR & RINEHART, LINWOOD, MD.
Ammoniated Bone Phosphate No. 1.
Ammoniated Bone Phosphate No. 2.

FARMERS' FERTILIZER CO., WESTMINSTER, MD.
Acid Phosphate.
No. 1 Bone Phosphate.
No. 2 Bone Phosphate.
No. 3 Bone Phosphate.
XX Bone Phosphate.

W. S. FARMER & CO., BALTIMORE, MD.
B. & P. Phosphate.
Clyde.
Harvest Queen.
Standard.
Tobacco and Potato Guano.

N. I. GORSUCH & SON, WESTMINSTER, MD.
Westminster Dissolved Bone.
Westminster 3 XXXX.

GRIFFITH, TURNER & CO., BALTIMORE, MD.
Animal Bone Phosphate. Soft Ground Bone.
Ammo. Alka. Plant Food. High Grade Acid Phosphate.
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Dissolved Bone.

HANWAY & KEEN, BEL AIR, MD.
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Complete Manure, "A" Brand.
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Vegetable Manure or Complete Manure for Light soils.

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High Grade Maynard's Choice.

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Ammo. Bone.
Bone and Super Phosphate.
Dissolved Animal Bone.
Dissolved Phosphate.
Dissolved S. C. Bone.
Fine Ground Animal Bone.
Globe Complete Manure.
Linden Super Phosphate.
O. K. Ammoniated Fertilizer.
Potato Food.
Sangston's Cereal and Plant Food.

GEO. W. MILLER, BALTIMORE, MD.

Miller's Mixture.
Miller's Wheat, Corn and Grain Grower.

MARYLAND GRANGE AGENCY, BALTIMORE, MD.

No. 2 Corn and Potato Fertilizer.
No. 1 Agency's Favorite.

F. MEHRING, BRUCEVILLE, MD.

Acid Phosphate.
Dissolved Raw Bone.
Emmerts' Half and Half.
General Crop Grower.
$26.00 Phosphate.

GEO. R. MOWELL, GLENCOE, MD.

Standard Bone Phosphate.
Pure Dissolved S. C. Rock.

J. B. NICHOLS, BALTIMORE, MD.

Farmers' Friend.

NORTH WESTERN FERTILIZER CO., CHICAGO, ILL.

Ammo. Dissolved Bone.
Prairie Phosphate.
Pure Ground Bone.

G. OBER & SONS, BALTIMORE, MD.

Ammo. Wheat and Grass Grower.
Avondale Ammoniated Dissolved Bone.
Dissolved Animal Bone.
Dissolved Bone.
Dissolved Bone Phosphate.
Dissolved Bone Phosphate and Potash.
Farmers' Mixture.
Farmers' Standard Ammoniated Phosphate.
Fish Bone and Potash Mixture.
Pure Bone Meal.
Special Ammo. Dissolved Bone.
Special Plant Food.
Special Compound for Tobacco.

PATAPSCO GUANO CO., BALTIMORE, MD.

Baltimore Soluble Phosphate.
Coon Brand Guano.
Dissolved Raw Bone.
Early Trucker.
Grain and Grass Producer.
Grange Mixture Dissolved Bone Phosphate.
Patapsco Tobacco Fertilizer.
Patapsco Ammoniated Corn Fertilizer.
Pure Ground Bone.
Pure Dissolved S. C. Bone.
Sea Gull Guano.
Special Wheat Compound.
Tobacco and Potato Fertilizer.

PIEDMONT MT. AIRY GUANO CO.|, BALTIMORE, MD.

Dissolved S. C. Bone.
Insula Guano for Corn and Oats.
Piedmont Potato Producer.
Piedmont Dissolved Bone Phosphate Potash Goods.
Piedmont Guano for Tobacco.
Piedmont Royal Ammoniated Bone and Potash.
Piedmont Raw Bone Mixture.

RASIN FERTILIZER CO., BALTIMORE, MD.

Ammoniated Alkaline Phosphate.
Ammoniated Super Phosphate.
Bone and Potash.

Dissolved S. C. or Acid Phosphate.
Empire Guano.
Ground Bone.
Rasin's Dissolved Bone.
Truck Guano.
Walker's Old Pittsburg Phosphate.
Walker's Economical Bone.
Walker's Dissolved Bone Phosphate.
Walker's S. C. Phosphate.
Walker's Victoria Bone.

W. E. ROBINSON, VALE, MD.

Tomato Grower.
Vegetable Fertilizer.

SHARPLESS & CARPENTER, PHILADELPHIA, PA.

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Dissolved Bone Phosphate.
Gilt Edge Potato and Tobacco Manure.

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Dissolved S. C. Bone.
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Top Dresser.
Truckers' Favorite.
Universal Guano.

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Dissolved Bone Phosphate.
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Farmer's Choice Brand.
Gardeners' and Truckers' Delight.
General Crop Grower.
Pure Bone Meal.
Pure Ground Bone.
Special Potato Grower.

SUSQUEHANNA FERTILIZER CO., BALTIMORE, MD.

Alkaline Bone Phosphate.
Ammo. Bone Phosphate.
Crop Grower.
Potato Phosphate.

Pure Bone Phosphate.
Pure Ground Bone.
Superior Rock Phosphate.
Soluble Bone and Potash.
XXV Phosphate.

H. S. TAVEAU & CO., BALTIMORE, MD.

Allenton Guano.
Special Compound.
Special Compound No. 2.

W. B. TILGHMAN & CO., SALISBURY, MD.

Bone Tankage Mixture.
Fish Mixture.
Fish Mixture "B."

E. S. TRUITT, SALISBURY, MD.

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Dissolved S. C. Rock.
Star Bone Phosphate.
Star Bone and Potash.
Standard Bone Phosphate.

M. E. WHEELER & CO., RUTLAND, VT.

High Grade Electrical Dissolved Bone.
High Grade Corn Fertilizer.
High Grade Grass and Oats.
High Grade Potato Manure.
High Grade Royal Wheat Grower.

WILLIAMS & CLARK FERTILIZER CO., NEW YORK.

Acorn Brand Acid Phosphate.
Royal Bone Phosphate.
Dissolved Bone and Potash.
Prolific Crop Producer.

F. M. WILSON & CO., POCOMOKE CITY, MD.

Favorite Truck Fertilizer.
Peninsula Ammoniated Super-Phosphate.

ROBT. A. WOOLDRIDGE & CO., BALTIMORE, MD.

Buffalo.
Chieftain.
Dissolved Bone.
Double Quick.

Florida Acid Phosphate.
Liberty Bell Potash Mixture.
Little Giant.
Special Potato.
Triumph.
Tuckahoe Bone.

ZELL GUANO CO., BALTIMORE, MD.

Ammoniated Bone Super-Phosphate.
Calvert's Guano.
Dissolved Bone Phosphate.
Dissolved Bone Phosphate Potash.
Economizer.
Pure Ground Raw Bone.
Special Compound for Potatoes and Vegetables.

Fertilizer Law of Maryland.

CHAPTER 397.

AN ACT to repeal sections one, two, three, four, five, six, seven, eight, nine, ten and eleven, of Article sixty-one, of Public General Laws, entitled "Manures and Fertilizers," as amended and re-enacted by Chapter three hundred and eighty-seven, Acts of 1890, and to re-enact the same with amendments.

SECTION 1. Be it enacted by the General Assembly of Maryland, That sections 1, 2, 3, 4, 5, 6, 7, 8, 9, 10 and 11, of Article 61, of the Code of Public General Laws, as amended and re-enacted by Chapter 387, of Acts of 1890, be and the same are hereby repealed and re-enacted to read as follows:

SECTION 1. That the term fertilizer, as used in this Act, shall be held to mean any commercial fertilizer, or any article, substance or mixture sold, offered or exposed for sale for manurial purposes within this State, of which the selling price shall be more than ten dollars per ton of two thousand pounds.

That the term brand, as used in this Act, shall be held to mean the name under which the commercial fertilizer is sold, together with the statement of the percentage of valuable ingredients contained therein.

That the professor in charge of the Chemical Department of the Maryland Agricultural College shall be *ex-officio* State Chemist, or (that the term State Chemist, as used in this act, shall mean the professor in charge of the Chemical Department of the Maryland Agricultural College.)

SEC. 2. And be it enacted, That before any fertilizer is sold, offered or exposed for sale within the State, the following conditions must be complied with: (1) The importer, manufacturer, manipulator, dealer or agent shall take out a license for the sale of fertilizer, which license shall be rated upon the number of brands contemplated to be sold at the rate of fifteen dollars for each brand; said license to be prepared and furnished by the Comptroller of the Treasury, and to be issued at any time, to be good until the first day of February following; provided, that when any such importer, manufacturer or manipulator shall have taken out a license as herein provided, it shall not be necessary for any other person, as his agent or representative, to take out a license to sell the fertilizers provided for by the party who has taken out such license. (2) Every bag, barrel - or package of fertilizer, and every parcel or lot, if sold in bulk, must bear in legible print, or be accompanied by a clear and true statement showing the net pounds of fertilizer in the package or lot, the name, brand or trade-mark under which the fertilizer is sold, the name and address of the importer, manufacturer or manipulator, the place of manufacture or manipulation, and a chemical analysis stating the per centum of the minimum, and only the minimum, contained therein of nitrogen or its equivalent in available ammonia, of potash soluble in distilled water, and of available phosphoric acid.

SEC. 3. And be it enacted, That any failure to comply with any or all of the conditions provided in section two of this Act, shall be punishable by a fine of one hundred dollars ($100) for the first offence, and of two hundred dollars ($200) for every subsequent offence.

SEC. 4. And be it enacted, That any person, firm or company selling or offering for sale any fertilizer in this State, or intending so to do, and not licensed by the Comptroller as provided by this Act, shall on and before the thirty-first day of July in each and every year, send his or their name or names with the postoffice address and the names of the kinds, brands and trade-marks, and of the manufacturer, importer or manipulator of each fertilizer sold or proposed to be sold to the Maryland Agricultural College, and the same shall be registered in suitable books kept for that purpose, and any failure to comply with the provisions of this section, shall be punishable by a fine of twenty-five dollars ($25) for the first offense and of fifty dollars ($50) for every subsequent offense.

SEC. 5. And be it enacted, That it shall be duty of the Maryland Agricultural College to analyze without cost or charge, all samples of fertilizer sent to it for the purpose of being analyzed by any person or persons purchasing or procuring the same in this State for his or their use or uses; provided, such persons are not interested in the analysis desired other than a consumer, of which affidavit shall be made and shall accompany each sample or brand; and further, such samples are taken and sent as described by this Act and free of cost of transportation to said college, and it shall be the duty of the Maryland Agricultural College to procure samples as far as practicable in every year, of all the fertilizers sold and used in this State, for the purpose of analyzing the same, and any duly authorized agent or representative of the said college shall have the right to take samples as provided by the Act from any lot or parcel of fertilizer in transit or in possession or keeping of any manufacturer, manipulator, dealer or agent, and sold or offered for sale in this State, and it shall be the duty of the Maryland Agricultural College to send in the result of every sample of fertilizer to the persons from whom such sample was taken or received, and also to publish from time to time the results of the analysis made by the said college of the samples sent to or procured by it for such purpose, and it shall be the duty of the Maryland Agricultural College when reporting or publishing the result of any analysis made, to state the commerical value in dollars and cents of the fertilizer so analyzed, per ton of two thousand pounds, such value to be based upon the analysis made by the college, and upon a standard of valuation to be ascertained, fixed and published by said college, annually, after conference with the proper officials of adjacent States.

Sec. 6. And be it enacted, That all samples of fertilizers for analysis at the Maryland Agricultural College shall be taken from unbroken packages that have not been injured in transit or by exposure, and when in the possession of purchasers within thirty days after coming into their possession, and every such sample when taken by an agent or representative of the college, shall be taken in the presence of the owner, agent or dealer in possession thereof, or of his or their representatives, and when by an owner or consumer, it shall be taken in the presence of one disinterested witness; and every sample shall be taken from a bag or package or a number of bags or packages, which shall not be less than five per cent. of the whole lot to which the sampling pertains; and in every case not over two pounds shall be taken from near the top, the bottom and the middle of the bag or packages sampled, and these portions shall be thoroughly mixed in a clean dry place, and a sutiable sample shall be taken from said mixture and placed in a suitable vessel or vessels carefully closed with identifying labels, both within and without the vessel or vessels, and the same then taken or sent by safe carriage to the said college for analysis; and there shall accompany every such sample a full and complete statement and description of the place and time of sampling, of the lot of fertilizer sampled, of all marks on the bags or packages thereof, and other facts relating to the same, and such statement and description shall be signed by the person who does the sampling and by the witness thereto.

Sec. 7. And be it enacted, That the funds received by the Comptroller from the licenses issued under this Act shall be paid into the Treasury and be set apart as a specific fund to pay the cost and expenses of conducting the analysis provided for in section five of this Act, and the Treasurer shall semi-annually pay over to the Maryland Agricultural College the money received from said licenses; provided, that the amount paid in any one year shall not be more than at the rate of fifteen dollars ($15) for each sample of fertilizer analyzed by the said College.

Sec. 8. And be it enacted, That any purchaser of fertilizer who shall be injured or defrauded by the contents of the bag, barrel or other packages, not conforming in quantity or quality to the marks, labels or statements on or accompanying the same, may recover from the seller or sellers thereof, in an action of debt, an amount equal to the purchase money of said fertilizer and the cost of suit; and in case the purchase is made of an agent of any person or persons residing out of the limits of the State of Maryland, or company or corporation whose principal place of business is out of the State, manufacturing, compounding, preparing and furnishing for sale any such commerical fertilizer, the purchaser thereof may, at his or her option, proceed by attachment, as now provided for by law in cases of non-resident and absconding debtors, against any property, rights or credit of any person, persons, company or corporation selling, manufacturing, preparing, compounding or furnishing said fertilizer when such property, rights or credits can be found within the limits of the State of Maryland.

Sec. 9. And be it enacted, That any manufacturer, dealer, agent or other person or persons who shall adulterate, add to or to take anything from any fertilizer, sold or offered for sale within this State, or who shall use the brand or trade mark of any manufacturer or dealer other than his own, shall be deemed guilty of a misdemeanor, and shall, upon conviction thereof in any Court having jurisdiction, be punished by a fine not exceeding two hundred dollars ($200) and imprisonment in jail not exceeding six months, or by fine and imprisonment at the discretion of the Court before whom he shall be tried.

Sec. 10. And be it enacted, That this Act shall not affect parties importing, manufacturing or manipulating fertilizer for their own use if not sold or disposed of; and it shall not apply to substances and materials sold in bulk to manufacturers or manipulators of fertilizer, and nothing in this Act shall prevent the buyer and seller from making contracts in reference to the price to be paid dependent upon the composition or quality of the fertilizer contracted for, but no arrangement or agreement, verbal or written, made by or between any seller and buyer of fertilizer in this State, for the purpose of exonerating the seller or manufacturer from liability for any violation of any of the provisions of this Act shall exempt any person from such liability.

Sec. 11. And be it enacted, That it shall be the duty of all State's Attorneys to prosecute all persons accused of violating this Act, or any of the provisions of this Act, or of the Act to which this is a supplement.

Sec. 12. And be it enacted, That this Act shall take effect on the first day of May, in the year eighteen hundred and ninety-four.

Approved April 6th, 1894.

FRANK BROWN,
Governor.
JAS. H. PRESTON,
Speaker of the House of Delegates.
JOHN WALTER SMITH,
President of the Senate.

MARYLAND

Agricultural Experiment Station.

BULLETIN NO. 53.

Special Investigation of the So-called "New" Horse Disease in Maryland.

College Park, Md.

MARCH, 1898.

MARYLAND

Agricultural Experiment Station.

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NOTICE.

The bulletins of the Station will be mailed free to any citizen of Maryland who sends his name and address to the Station for that purpose.

Correspondents will please notify the Director of changes in their post-office address, or any failure to receive the bulletins.

ADDRESS,

MARYLAND AGRICULTURAL EXPERIMENT STATION,
COLLEGE PARK, MD.

R. H. Miller, Esq., Director,

Maryland Agricultural Experiment Station,

Sir:—

Pursuant to your instructions of the 30th ultimo, regarding co-operation with the State Veterinarian in the investigation of the malady existing among horses in the State at that time, I visited the several sections reported as being infested, and tender herewith my report of said investigation.

Respectfully yours,

College Park, Md.,

23rd October, 1897.

Samuel S. Buckley,

Veterinarian.

SPECIAL INVESTIGATION

OF THE SO-CALLED "NEW" HORSE DISEASE IN MARYLAND.

By Dr. Samuel S. Buckley.

Having been informed that the "new" horse disease was prevailing to a great extent in Worcester County, Maryland, I repaired immediately to Snow Hill, its County Seat. Upon my arrival I learned that the trouble had abated, and at that time no case was to be found. The following information I received from reliable sources:

First: That death resulted in nearly every instance.

Second: That horses at pasture were more often affected than those in the towns; but pasturage was not essential to its development, as a number of horses died that had not been grazing for two or three years.

Third: Affected horses rarely received treatment.

Fourth: The general opinion was that the young horses and colts were more susceptible to the disease. Old horses, however, contracted the disease and died of it.

Fifth: The ration usually fed in that section consisted almost exclusively of corn and corn fodder (the top fodder and blades). Pasturage as a rule was inferior.

Pocomoke City was next visited, where I could learn of but one case, which was eight miles away on the boundary line of Maryland and Virginia. In the country immediately surrounding Pocomoke, the disease had not been so severe as to occasion any alarm. Few cases had been reported. On account of the inaccessibility of this point, and the fact that I would have been delayed more than twenty-four hours, I failed to visit the above-mentioned case, and proceeded at once to Westover, Somerset County. This lies in the Fairmount District. Throughout this section the disease had been extremely prevalent, and fatal. The history of the disease here was simply a record of deaths. Up to the time of my arrival, there had been nineteen cases within a radius of three miles from Jamestown, and eighteen of these resulted fatally.

The cases seen by me here are given separately, as follows:

Case 1: Seen late on the evening of the 5th instant. The animal was taken sick on Saturday morning, and on Sunday got down. Remained in a semi-comatose condition up to the time I saw it, Tuesday evening. The body was very much emaciated, and the skin was knocked off the side of the head and legs, due to the movements of the animal after falling. The ears, nose and legs were cold, as was the entire surface temperature. Pulse very weak and respirations normal. The hind quarters were almost completely paralyzed. Had been growing weaker more rapidly during the last few hours. Early the next morning I was given permission to destroy him, which I did by opening the carotid artery and jugular vein. The blood from the vein was darker than normal and flowed sluggishly from both artery and vein, though the exit was unrestricted.

Post-mortem examination showed the stomach congested, and nearly filled with a foetid yellow fluid. It contained no solid matter. The intestines contained a similar fluid, and no solid matter, except at the rectum, which had a natural amount of faeces, normal in appearance, with the exception of a small amount of mucous covering the pellets. The bladder was distended with a large quantity of a pale yellow and syrupy urine. The kidneys were normal. The liver was paler than normal, and easily torn. The spleen was unaltered. The heart was normal, and the lungs so with the exception of the lobe on the side upon which the animal had lain. This was congested, but only slightly so. The meninges (brain coverings) had their blood vessels distended, though this was not so exaggerated as is found in some cases. One of the characteristics of this disease was pronounced, that of an extremely foetid condition of the nasal passages.

Case 2: October 6th. This was reported as being a case of the "new horse disease," but proved to be a case of spasmodic colic, which was treated and recovered. This is mentioned to show that very often cases are reported as having recovered spontaneously from this disease where the diagnosis has been wrong. In the same way deaths are often attributed to this disease which properly come under another category.

Case 3: October 6th. Diagnosed as the early stages of this disease. Ordered removal to a large shed, and dieting on bran mashes and timothy hay. Gave hypodermically one grain of sulphate of strychnine, and repeated three times a day. Applied cold water to the head every hour. Continued this treatment throughout for five days, and then gave a tonic of nux vomica and quinine. The symptoms became more alarming up to the middle of the third day, when a change set in and improvement continued until recovery was complete. The temperature was never higher than 102.6.

Case 4: October 8th. Diagnosed the disease in a little further advanced stage than case No. 3 when found. Temperature 102.2. Horse had been worked hard all day and seemed well until toward evening, when she appeared dull. Gave hypodermic injections of strychnine at 7:00 P. M., and left directions for applications of cold water to the head. Was unable to see her again until 11:00 A. M. of the next day. Found her leaning against the stable in the sun, where the heat was intense. Water had been applied but once during the morning. Temperature at that time was 104.2. The animal was very weak, and staggered when walking. Continued the administration of strychnine, but was unable to have the application of water continued. She died the next day during my absence in returning to the Experiment Station, and I was unable to hold a post-mortem.

Case 5: This case was taken on Sunday, October 10th, and had been given strychnine three times up to the time of my return on Monday. I had taken a set of slings with me, and placed him in these at once, as he was in imminent danger of falling from weakness. He had already fallen a couple of times, but had been able to regain his feet. The surface temperature at the poll of the head was only slightly elevated. The ears and nose were cold. Breath becoming foul. Appetite gone. Continued the strychnine and applications of water. October 12th, no apparent improvement. Breath more foul. Had taken neither food nor water since becoming sick. Finding the heart in good condition I began the administration of aconite, and on the next day found patient looking brighter, though very weak. During the day he drank some water and ate a very little. I removed a quantity of faeces manually, and succeeded in causing a flow of urine. This was the first discharge of either in three days. The appetite gradually returned, and the excretions took place naturally. The breath became less offensive. He regained strength rapidly, and in a week's time thereafter recovery was complete.

The details of the symptoms, course of the disease, etc., have been reserved for special consideration.

Having assured myself that the disease is the same as that described by Professor Large, of Brooklyn, N. Y., under the name "Cerebro-spinal Meningitis," and retained by Doctor M. R. Trumbower, in "Diseases of the Horse," I will give a minute description under the same title from the cases observed with recommendations for treatment, and the care to be exercised looking to its prevention.

CEREBRO-SPINAL MENINGITIS.

In the enzoötic form of this disease there is but slight variation in the symptoms in different individuals. While the character of the symptoms are nearly identical, they show a considerable variation in intensity.

Usually the first appearance of any abnormal condition is a lethargy or stupefaction; occasionally, however, excitement prevails. Other symptoms then follow in rapid succession. Brain disorder is clearly indicated from the first. Upon careful examination, we find a slight elevation of temperature at the poll of the head, which usually increases to a considerable degree. In some cases excessive heat at this point is absent. The tips of the ears are unnaturally cold. Apparent blindness may be present. The eyes are dull, and are rather more anaemic than congested. The nose and muzzle are cold. Upon examination of the mucous membranes of the nostrils, we find a bluish tinge. The breath rapidly becomes foetid, and later a muco-purulent discharge comes away. The mouth is cold and clammy. Shortly after the first symptoms are noticed, there is a severe grinding of the molar teeth. The pulse is normal at first, but becomes slightly accelerated. The neck is rigid; its tense muscles drawing it slightly to one side or backward. The heart is regular. The respirations normal and are but slightly altered throughout the attack. The muscles of the thigh and buttock often twitch. The temperature varies from normal to 104 degrees. The tail is limp, and unresisting, though its functions are not interfered with. The extremities are cold, though not so marked as the nose and ears. Weakness comes on rapidly. There may be simply a tendency to lean against objects and resting the feet of the opposite side, or a desire to walk to one side, giving to themselves a circular course. The appetite is lost or impaired. Often there is an inability to swallow solids or fluids, due to paralysis of the tongue and pharynx.

As the disease progresses we find all the symptoms aggravated. Musclar weakness increases, and the animal will stagger and fall. Being down they are seldom able to rise. While down and in a semi-comatose condition they will toss their heads and continue the grating of their teeth as if suffering intensely. Salivation is noticed. Paroxysms come on at irregular intervals, followed by greater weakness than before. During these paroxysms the legs are moved incessantly as during locomotion. Complete coma may soon come on, and finally the animal dies.

If recovery is to occur, we will find a gradual increase in strength and return of the appetite. The offensiveness of the breath becomes less noticeable, and disappears entirely after two or three days. The excretions take place naturally, and at regular intervals. Recovery takes place about as rapidly as the symptoms have appeared.

POST-MORTEM APPEARANCES.

The rapidity and severity of the symptoms bear no definite relations to the extent of the lesions found. Frequently we find the cheeks of pharynx containing a mass of food. The stomach is slightly congested in some cases, and in others it is normal. The intestines are unchanged except that posteriorly the colon and rectum contain dry faeces. The liver is pale and friable. The spleen and pancreas are unchanged. The kidneys are natural in size and color. The bladder is often distended with a straw-yellow urine. The heart is unchanged, and the lungs usually so, though in cases which have been down for a considerable time there may be a slight congestion on the under side.

The meninges of the brain and spinal cord show evidences of a greater or less degree of congestion. The septum nasi (cartilage of the nose) is covered with an extremely foetid mucous. Its blood vessels are injected, giving to its surface a very dark coloration. The sinuses surrounding are more or less involved.

PROGNOSIS.

The probability of a recovery is very unfavorable in some cases, better in others, though in all cases the prognosis should be guarded. Those cases in which the symptoms appear gradually, are more favorable. The condition of the appetite is one of our best guides in the early stages of the disease for basing our prognosis.

TREATMENT.

On the first appearance of this disease upon a farm, a complete change should be made in the food. All mouldy grain or fodder should be rejected, and where possible, wheat bran should form part of the ration.

It is evident that in so severe and rapidly fatal a malady, powerful agents must be used. Proper nursing is necessary for success. Without it medicines avail but little. Placing the animal in slings early acts very beneficially in preserving their strength and increases the chances of recovery. When there is any considerable degree of heat at the poll of the head, we should resort to the constant application of cold water, crushed ice, or some cooling lotion (nitrate of potash and acetate of ammonium, each a teaspoonful to a gallon of water). In the early stages these tend to check the flow of blood to the brain, and therefore reduce pressure upon it. Among medicinal agents we have recourse to ergot, aconite and belladonna. Nux vomica and strychnine seem to be capable of producing desirable actions. As all of these are extremely powerful and poisonous, they should be used where possible under the supervision of a veterinarian, so that their effects might be watched and their omissions ordered, if necessary. Maintaining the appetite with tempting foods and drink should be done. Purgatives and bleeding are to be avoided, as they seem to prove disastrous after the symptoms have become fully established. When the crisis has been passed and the animal begins to take nourishment tonics containing quinine and nux vomica should be given.

CAUSE AND PREVENTION.

Numerous theories have been advanced as to the probable cause of this disease, but up to this time experimentation has not been carried on sufficiently long to give us positive results. Its cause has been attributed to marshy lands, impure water, intense dry heat, to various plants and weeds, grain damaged by insects, and, in fact, to almost everything.

The Delaware Experiment Station has carried on several experiments with foods in the past few years with negative results.

A disease appearing in Kansas, very similar in nature, and described under the name "staggers," is said to be due to the fungus *Aspergillus glaucus*. However, experimentation will be necessary in order to ascertain whether this growth is responsible for our trouble.

In the report of 1891 of the Kansas Experiment Station, regarding the post-mortem lesions of this trouble, it speaks of an inflamed condition of the liver, and an abscess formation upon the brain. These lesions have not been found so far in the post-mortems of our diseased animals.

It is evident that owing to the severity of the disease, and its wide spread appearance among us, there should be carried on careful and thorough experiments in order to ascertain positively the cause, and allow us to intelligently direct means of prevention and treatment.

MARYLAND

Agricultural Experiment Station.

BULLETIN NO. 54.

Tomatoes.

College Park, Md.

March, 1898.

MARYLAND
Agricultural Experiment Station.

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NOTICE.

The bulletins of the Station will be mailed free to any citizen of Maryland who sends his name and address to the Station for that purpose.

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ADDRESS,

MARYLAND AGRICULTURAL EXPERIMENT STATION,
COLLEGE PARK, MD.

Tomato Experiments.

SUMMARY OF RESULTS.

1.—The varieties giving the largest early yields are Early Ruby, Potato Leaf, Prize Taker, Autocrat and Canada Victor.

2.—The best varieties for main crop trucking are Paragon, Prize Taker, Perfection, World's Fair and Climax.

3.—The best varieties for the canning trade are Royal Red, Queen, Stone, Paragon, and Matchless.

4.—The best variety for late market or family use is the Buckeye State.

5.—The use of the Bordeaux Solution proved an effectual means of holding the tomato leaf blight in check.

6.—In 1896 spraying with Bordeaux Solution four times produced with 35 varieties, an average increase in yield of 2.5 tons per acre of marketable fruit.

7.—In 1897 spraying with Bordeaux Solution three times produced with 19 varieties an average increase in yield of 2.2 tons per acre of marketable fruit.

8.—Some varieties are more susceptible to the blight than others. In 1896 all but one variety, and in 1897 all but three varieties gave an increased crop of ripe fruit as a result of spraying with Bordeaux Solution, and all of the varieties showed an increase when the amount of green tomatoes at the end of the season are added.

9.—The increase in crop as a result of spraying, ranged from ¼ of a ton to 6 tons in 1896, and from ¼ to 4¼ tons in 1897.

TOMATO EXPERIMENTS, 1896 and 1897.

By James S. Robinson.

The tests conducted with tomatoes during the seasons of 1896 and 1897, were confined to the two lines which were deemed of the most general interest to growers in this State, viz:

1st. Tests of varieties.

2nd. Tests of the use of the Bordeaux Solution for the tomato blight.

Tomatoes may be grown under a very wide range of conditions of soil and culture, which makes them of special interest to a very large class.

The tomato may well be considered a staple horticultural crop of this State, and to occupy the same relative position with the horticulturalist that corn does with the agriculturalist, provided all who grow tomatoes, can be properly classed in the horticultural ranks; yet it is doubtful if all tomato growers should rightfully be considered horticulturalists, from the fact that many grow this crop on the first attempt successfully, who would make a failure in almost every other branch of the business.

The tomato crop in this statement may be divided into three general classes.

1st. Tomatoes grown and ripened under glass for winter and early spring fancy trade.

2nd. Tomatoes started under glass, but grown on the early truck lands and sold for early and immediate consumption.

3rd. Tomatoes grown as a field crop and for the use of the canneries.

While all of these interests are fairly distinct as to the methods pursued in culture and the markets which they supply, yet they all have a common interest in the adaptability of varieties to their special needs, and have to combat with the same enemies in growing.

THE PLANT BED: An examination of the methods pursued and the conditions surrounding the seed bed and the early life of the plant has made it very evident to me that much of the trouble we now have with tomatoes can be attributed either directly or indirectly to that period in the early life of the plant before it is transplanted to the garden or field.

For early plants which are grown in the hot bed or cold frame, the common custom, is to sow the seed in February or early in March. With these provisions, no trouble would be experienced, if the weather conditions were always what is desired; but the rule is to have cold spells, with considerable cloudy and damp weather. During such times, it is necessary not only to keep the sash on the beds, but to have the whole covered with straw or some such material. This covering not only prevents all opportunity for proper ventilation, but excludes as well, the necessary amount of light, which is always of great importance to the plant, and especially so at this stage of its life. This, together with the fact that the bottom heat which exists in a hot bed produces a favorable condition for root activity, causes an abnormal functional relation between the root and the foliage systems.

Again, even these unfavorable conditions are often aggravated by injudicious and untimely watering. In the above particulars, I believe may be found the primary cause for what is technically known as the oedema of the tomato.

In the case of growing plants, when the crop is to be used for the canning industry, the general practice is to sow the seed in the open border in April, and transplant direct from there to the field. An examination of a number of such plant beds during the season of 1897, showed without an exception, that the foliage of the plant was more or less injured by the flea beetle, and in some cases also by the Colorado potato beetle. This means starting operations with enfeebled plants, making them more susceptible to disease or insect ravages which they may be subjected to, and result in decreasing the crop.

The tobacco growers have found it necessary to cover their plants with hot bed cloth to protect them from insect injuries, and I am firmly of the opinion that the tomato grower will find greatly to his advantage to follow the same course. I made during the past season some tests of the use of this covering in growing tomato plants, and found it to work very satisfactory, and give much stronger and healthier plants, somewhat earlier, and entirely free from the evidence of insect ravages. Hot-bed cloth is comparatively inexpensive, costing one and one-half cents per yard. It comes one yard wide, and may conveniently be used singly or two breadths sewed together. A very good way to use it, is to set up six inch boards on edge, parallel to each other upon which to tack the cloth. These boards may be raised gradually to accommodate the growth of the plant or to permit the free circulation of air.

LAND USED FOR EXPERIMENTS: The land used for the variety and spraying experiments is quite uniform throughout. It is a heavy loam. with considerable admixture of gravel, being a portion of that devoted to the horticultural department, and lying in front (east) of the Station building. It has been used for growing a variety of vegetables during the past nine years, and has received during this time several coats of stable manure. The land used in 1896 was in tomatoes the year previous. A coat of stable manure was applied in the fall and plowed under. In preparing the land for planting, it was marked out with a plow 4x5 feet and at each intersection, where the plant was to be placed, there was a hill made by working into the soil an ordinary four pronged pitch fork full of well rotted manure.

The land used in 1897 was in melons the year previous and it received an application of commercial fertilizer just before planting.

FERTILIZER: The land previous to planting in tomatoes, was marked off in squares by drawing furrows 5½ feet each way and the commercial fertilizer sowed in the rows at the rate of 500 lbs. per acre. The fertilizer used was a home mixture, made up of the following ingredients in the proportions indicated:

Nitrate of soda	200 lbs.
Dissolved South Carolina Rock (14 per cent.)	1000 lbs.
Dried ground fish	500 lbs.
High grade sulphate of potash	300 lbs.
	2000 lbs.

(This would have approximately the following composition:

Phosphoric acid (P2O5)	9 per cent.
Nitrogen (calculated as ammonia)	4 per cent.
Potash (K2O)	7½ per cent.

VARIETY TESTS.

In the variety tests, the aim has been to make them in such a way that the results would have an application wherever tomatoes are grown, yet we recognize the fact that the same varieties are not universally adapted to all soils and conditions, but yet, nearly enough so to make a general application of the results of about equal value throughout this State.

In making a selection of the varieties to be tested, the aim has been to get all those novelties and new varieties which would seem to have promise to be of interest for either forcing, trucking, or canning, and compare them with the standard and well recognized varieties for these several purposes. In making tests of forcing varieties, we have been at the disadvantage of not having at our command a green house, so that that portion of the work could not be carried out to the full extent, but had to stop with the preliminary portion of taking observations of habits and characters of growth and fruit, and making records of yields, etc.

SIZE OF PLOTS: In the tests made in 1896, the plots consisted of one row devoted to each variety and 20 plants to each row. The rows were five feet apart and the plants were four feet apart in the row of 400 square feet to each plot.

In the tests made in 1897 the plots consisted of one row devoted to each variety and 12 plants to each row. The rows were 5½ feet apart and the plants 5½ feet apart in the row or 363 square feet to each plot.

Time of sowing seed and transplanting: The seed for the test of 1896 was sown May 22nd, in the cold frame: transplanted to thumb pots June 4th, and set in the field June 15th. The seed for the test of 1897, was sown in the cold frame May 8th, and transplanted direct from the plant bed to the field June 18th.

The names of the varieties tested during 1896, are given in table 1, page 126, of those tested in 1897, in table 6, page 130. In these tables will also be found the total yield per picking and date of picking. From these tables the following are selected as the best five for use of the trucker, growing for the early market, as they begin to ripen earliest, and give the greatest amount of fruit during the first month of picking:

	Variety.	Color.	Habit of Growth on scale of 10.
1	Early Ruby.	Red.	7
2	Potato Leaf.	Purplish.	8
3	Prize Taker.	Purplish.	9
4	Autocrat.	Purplish.	9
5	Canada Victor.	Red.	8

The very earliest tomatoes are as a rule, irregular in shape, and will give way in price to the better varieties, as soon as these come on the market in quantity. The following are very early varieties, but are poor shaped and are not reliable yielders:

	Variety.	Color.	Growth on scale of 10.
1	Michigan Early.	Red.	10
2	Early Acme.	Red.	8
3	Advance.	Red.	7
4	Atlantic Prize.	Red.	7
5	Prize Winner.	Red.	8

The following varieties can be recommended to truckers, as they produce a good crop of smooth tomatoes, and if they should not have sale for them for immediate use, they are of a quality that can be disposed of to the canners to advantage. These varieties will also continue to bear well for a considerable period.

	Variety.	Color.	Habit of Growth on Scale of 10.
1	Paragon.	Red.	9
2	Prize Taker.	Purplish.	7
3	Perfection.	Red.	9
4	World's Fair.	Red.	8
5	Climax.	Purplish.	9

The canner desires tomatoes which are firm, smooth, of good color, ripen early and well up to the stem, and at the same time give a large yield. The five varieties possessing these requisites in the greatest degree are as follows, given in order of yield:

	Variety.	Color.	Habit of Growth on Scale of 10.
1	Royal Red.	Red.	10
2	Queen.	Red.	9
3	Stone.	Red.	9
4	Paragon.	Red.	9
5	Matchless.	Red.	9

For a late market or family use, the Buckeye State is one of the best. It is a purplish tomato with a strong habit of growth, the fruit is very solid, and is less liable to crack than many of the other popular varieties.

Nos. 28, 29 and 30, which are omitted from table 1, crop of 1896, were respectively, the Purple Husk, Golden Husk and Golden Pear, and no records of the yield of these were kept, as none of them have any special commercial value, but may be regarded as varieties having interest only as indicating the variations in form and size in this crop. The only one of these that is found in the market is the Golden Pear and it finds but very limited sale. In general it may be said, that only a very few of the great number of new varieties that annually come to public notice, ever measure up to the claims made for them by their originators, or ever prove to possess enough value to make them worthy of general adoption by the commercial grower, and each test of this sort, only adds more evidence, to the effect that new varieties in any line, should be touched cautiously, and that the commercial grower should adopt for his crop such varieties as are true and tried, and have been weighed in the balance and not found wanting.

THE TOMATO BLIGHT.

The tomato leaf blight, sometimes called simply "Tomato Blight" or "Southern Tomato Blight" has been so prevalent and disastrous to the tomato growers in every section of this State during the past two or three years, as to make it an object of special interest and inquiry. To meet this demand for information, the tomato blight has been made a special study for experimentation during the seasons of 1896 and 1897. The lines along which the research and tests have been conducted are about the same as has been suggested on several occasions by other investigators, yet in most cases, there has been nothing more than a suggestion made as to a course for the grower to adopt, and in no case, reported up to date, have the results been of that character which was convincing and satisfying to the ordinary grower. The first serious outbreak of this disease in this State, as far as I am aware, occurred about twenty years ago in the vicinity of Baltimore City. Since that time, other sections have been more or less involved and the severity of the trouble has been much more marked during some years than others, yet, never has it been so wide spread and prevalent, and affected the tomato industries of both trucker and canner as disastrously as it did the season of 1897.

The tomato leaf blight is a plant disease, caused by a bacterial germ, and may begin its attack when the plant is very young in the seed bed, or at any stage thereafter. It always begins by attacking the older or lower leaves first and gradually extends upwards. The appearance of the disease can first be recognized by the color of the leaf, which is slightly lighter, and also by a slight thickening and curling of the margin of the leaf. This is followed by the appearance of brown spots, which ultimately results in the leaf dying and dropping off. The effect of this loss of foliage, is an enfeebled condition and impairment of plant vitality, which causes a greater or less decrease in the quantity and quality of the crop, depending on the severity of the case. In some cases, with good cultivation, and conditions unfavorable to the development of the disease, the plant will outgrow the effects of the blight to a certain extent, yet even in such cases, there will be some deterioration in the quality of fruit through lack of shade, which will produce uneven ripening and sun scalding.

The tomato eodema is sometimes confounded with this blight, and in other cases, different condition is described, because of the existence of both eodema and blight on the same plant. The eodema shows on the younger and terminal foliage, while with the blight, the terminal foliage is always the most healthy. The eodema may often show on a few plants in the field, which will produce scarcely any fruit; whereas, with blight, the trouble is likely to be general.

Tomato blight may be contracted by the plant through a number of agencies.

1st. Through the use of seed from diseased and enfeebled stock.

2nd. Through the agency of the spores which may live over in the soil of the seed bed or the field. The spores of this disease attacks many other plants besides tomatoes, especially, the potato, also some common weeds belonging to the same family of plants. Consequently great care should be taken not to follow in rotation plants which are subject to this disease, or to even plant them in closer proximity to one another than necessity enforces.

3rd. The infection may be produced through the agency of insect pests. To test this point more fully than ordinary observations made possible, I took some Colorado potato beetles that were feeding on potatoes that were blighted, and put them on some isolated and protected tomato vines, preserving others as checks. The result was as would be expected from the relationship of the plants; that the plants so inoculated were blighted, the checks not inoculated, showing no evidence of the disease.

Many other insects no doubt, can produce the same result, and notably so, the flea beetles, which feed in common on all of this family of plants. The Aphis which is so frequently found on tomatoes, and is sometimes thought to produce the condition caused by the blight, is, I believe in no sense, the cause of the disease, but only produces an enfeebled condition in the plant, which makes it more susceptible, and the progress of the disease more rapid.

EXPERIMENTS CONDUCTED: After some preliminary work and observations, which it is not necessary to give in detail in this connection, it was deemed most profitable to confine the work during the season of 1897 to the use of the Bordeaux spray after the plants were set in the field. For this purpose, and also to test if some varieties were more susceptible to the disease than others, the variety plots were divided into two parts, one-half was sprayed, the other half left untreated.

In 1896, the plants were sprayed four times on the following dates: On June 6th, while the plants were in the seed bed, and in the field on July 8th, 18th and 28th. The details as to pickings and yield per plot from the sprayed and unsprayed portions, with the 35 varieties used, are given in tables 1 and 2 on pages 126 and 127. The yields per acre, calculated in tons and bushels are given in table 3, page 128.

In 1897, the plants were sprayed three times, viz: July 14th, July 24th and August 6th. The details as to pickings and yield per plot from the sprayed and unsprayed portions, with the 19 varieties used this season, are given in tables 5 and 6, pages 130 and 131. The yield per acre, calculated in tons and bushels are given in table 7, page 132.

In tables 4 and 8, pages 129 and 133 are given the quantity of green tomatoes gathered at the end of the season from the sprayed and unsprayed sections for the years 1896 and 1897, respectively. These yields do not figure in the results given in tables 3 and 7, (which are of ripe and maketable crop), as green tomatoes do not have any commercial value, except to a limited extent by a few truckers. The quantity of green tomatoes is interesting, as given additional evidence of the value of spraying in holding up the crop.

A review of the results given in the tables, gives unmistakable evidence of the value of the use of the Bordeaux solution in growing tomatoes which are likely to be affected by blight. The spray was in no sense a cure or even a complete preventive, yet, by its use, the disease was held in check to a great extent, so that the plant was able to carry on the functions of the developing and maturing of the fruit, so as to produce a marked increase in the crop, as shown in the tables. The average increase produced as a result of the spraying of the 35 varieties in 1896, was 2.5 tons per acre, and in 1897, with the 19 varieties tested, was 2.2 tons per acre.

By an examination of the figures given in the tables, it will be seen that some varieties were much more susceptible and gave way more to the ravages of the blight than others, but yet, in all cases, the spray proved effective in holding it in check. The increase of crop produced as a result of the spraying, ranged from ¼ ton to 6 tons per acre. In examining the above results, it must be kept in mind that the favorable results were obtained under what would be considered very unfavorable conditions, as the sprayed plants were in close proximity to the diseased plants, there being no separation whatever, but a continuation of the same rows.

CONCLUSIONS AND SUGGESTIONS.

From the results and observations of the work herewith reported together with general observations and the reports made upon the subject in agricultural literature, I believe it is safe to say that the Bordeaux Solution is valuable in holding this tomato leaf blight in check, but that it can in no sense be considered a remedy, or even a complete preventive. That the increase of crop will pay for the expense involved in making the applications, and that all truck growers in districts where this blight prevails, should adopt the precautionary measure of spraying with Bordeaux. Observation and experience has proven that the earlier the spraying is commenced, the more effective it is in checking the progress of the blight. In fact, I believe that the best place to begin the spraying is in the seed bed, and probably it would be a wise measure to spray the soil of the seed bed and also give the seed a slight spraying before it is sown.

It is evident that soil may be contaminated with the bacterial germ producing the blight, hence two crops of tomatoes should not be grown on the same land in succession, nor should tomatoes follow potatoes, or any class of plants, that are likely to be affected with the same blight. Also, it would be well to keep these different crops as widely separated each year as possible. It may be well to burn the refuse matter left on the field at the end of the season from all this class of crops, to prevent the spores from wintering over and being ready to attack the next year's crop.

DISTANCE APART FOR PLANTS: Conditions favorable for the development and spread of blight, will be found in warm dry spells of weather, and crowded conditions of plants, particular in the seed beds. In starting the seed bed, it will be advisable to sow the seed thinly in drills, six or eight inches apart, so as to insure a strong, stocky plant development. Distance apart for the plants in the field should be determined by the habit of growth of the variety selected and the strength of the land. 3 feet x 4 with some varieties, and under some circumstances is a better distance at which to set the plants than 4 feet x 5 with other varieties and different surroundings. I think it a good point to make the rows wider one way than the other, for the reasons that a better opportunity would be afforded for spraying as well as gathering the crop, without injury to the plants, and it is sometimes desirable to continue the cultivation longer than close planting both ways would permit. It should be borne in mind, that the attention necessary to protect the plants in the seed beds is neither expensive nor laborious, that the theory of dealing with the blight is on the line of prevention and that the promise of best results is to start the crop with healthy plants, if possible.

BORDEAUX SOLUTION.

We make these suggestions for preparing the Bordeaux mixture for use in spraying tomatoes for the blight. 8 lbs. copper sulphate, 4 lbs. good. quick lime and 40-50 gallons water are the proportional materials. It is advised in the preparation. to have three wooden vessels so as to insure a complete, mechanical admixture of the ingredients. After putting in one of the vessels from 20-25 gallons of water, suspend in this the 8 lbs. of copper sulphate, it may be put in a bag of loose texture. This suspension is necessary in order to have a quick and complete solution. In another vessel, slack the lime with hot water, using water enough to slack it to a soft paste; add to this 20-25 gallons water, mix well. and strain to rid it of any impurities that might clog the spray nozzel. We wish now to thoroughly mix the lime water and copper solution, this can be done by pouring the contents of the two vessels simultaneously in the third, or by having two parties with a bucket each. When a combined spray is needed to protect the plants from insects as well as fungous troubles, add to the 40-50 gallons Bordeaux 4 oz. Paris Green. In applying the spray it is very important that the admixture is kept complete by agitation. Most spray pumps have devices for this.

TABLE I.—Results of Test of Varieties and Treatment for the Prevention of Tomato Blight.

YIELD OF PLOTS SPRAYED WITH BORDEAUX SOLUTION.

Size of Plots, 200 Square Feet, 1896.

Plot N	Varieties.	DATE OF AND YIELD AT EACH PICKING.																				Total.	
		Aug. 18		Aug 22		Aug. 26.		Aug. 29.		Sept. 7.		Sept. 16.		Sept. 19.		Sept. 24.		Oct. 2.		Oct. 16.			
		Lbs.	Oz.	Lbs.	Oz.	Lbs.	Oz.	Lbs.	Oz.	Lbs.	Oz.	Lbs.	Oz.	Lbs.	Oz.	Lbs.	Oz.	Lbs.	Oz.	Lbs.	Oz.	Lbs.	Oz.
1	Liv. Favorite	.....	.....	2	0	1	1	1	6	4	8	15	2	4	12	6	5	13	0	11	7	59	9
2	Golden Queen	0	10	1	5	1	6	2	1	3	15	16	11	4	3	5	12	20	3	8	0	64	2
3	Michigan Early	2	3	4	13	1	9	2	4	12	9	13	14	3	10	4	12	26	2	16	4	88	0
4	Trophy	0	13	0	8	3	2	0	6	5	10	37	12	3	15	4	7	27	0	16	9	100	2
5	Liberty Bell	.....	.....	2	0	0	5	0	9	4	1	25	11	5	9	13	3	33	8	14	4	104	2
6	Atlantic Prize	.....	.....	2	0	3	10	1	11	12	14	33	12	2	10	10	8	25	7	3	2	95	10
7	Royal Red	.....	.....	1	7	1	10	.....	.....	11	6	21	14	5	2	10	0	30	2	19	0	100	9
8	Ponderosa.	.....	.....	.....	.....	1	14	1	2	2	7	23	1	2	9	3	11	13	3	9	0	56	15
9	Paragon	.....	.....	2	13	5	1	1	0	10	0	31	14	4	4	11	10	28	2	16	9	111	5
10	Matchless	0	15	2	2	3	3	2	14	10	12	26	6	5	7	5	9	30	3	11	4	98	11
11	Early Acme	1	8	3	15	1	7	0	9	11	12	26	2	2	15	8	7	34	8	7	11	98	14
12	Advance	0	7	3	12	1	12	2	5	15	15	29	4	3	15	6	1	8	0	0	12	72	3
13	Democrat	0	8	2	2	0	14	0	13	6	13	15	5	3	9	2	15	23	0	9	3	65	2
14	Autocrat	.....	.....	2	6	1	10	1	5	6	13	48	12	3	1	5	5	19	4	13	8	102	0
15	Canada Victor	1	6	4	10	4	7	2	13	20	6	28	11	5	0	10	15	21	0	3	13	103	1
16	Potato Leaf	2	0	4	3	2	13	3	6	16	14	44	7	2	6	7	9	17	1	4	14	105	9
17	Rose Peach	0	0	0	11	5	0	2	10	10	8	32	4	16	4	13	2	20	0	18	12	119	3
18	Purple Peach	.....	.....	.....	.....	0	12	0	11	5	7	15	12	11	13	8	12	14	12	15	8	73	7
19	Golden Ball	0	12	1	12	0	15	0	11	7	12	16	4	7	5	19	7	24	4	15	4	94	6
20	Cincinnati Purple	3	0	2	15	2	8	0	15	7	5	25	14	2	12	6	14	16	5	12	14	81	6
21	New Imperial	2	5	4	6	3	12	3	10	10	3	27	2	3	7	4	14	22	2	9	0	90	13
22	Early Ruby	6	8	11	3	15	7	8	10	27	12	13	14	1	8	2	15	6	14	1	15	96	10
23	Essex Hybrid	1	9	4	2	3	7	2	12	19	4	24	4	2	9	8	12	22	7	2	6	91	8
24	Acme	2	7	3	14	3	5	1	4	17	14	17	6	3	0	6	13	19	14	3	6	79	3
25	Beauty	2	5	5	13	2	12	1	10	13	8	19	12	2	6	3	11	14	13	6	0	72	10
26	Dwarf Aristocrat	0	9	0	11	1	8	0	7	4	4	16	5	1	10	2	8	8	3	0	15	37	0
27	Dwarf Champion	1	1	1	3	0	6	1	11	7	9	10	12	2	1	2	10	4	8	1	3	33	0
28	Purple Husk	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
29	Golden Husk	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
30	Golden Pear	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
31	Truckers' Favorite	.....	.....	1	3	4	8	1	13	10	15	27	3	1	15	4	15	18	8	7	4	78	4
32	Ford Hook.	3	9	4	14	2	8	3	13	22	4	17	14	1	15	4	4	9	9	2	2	72	12
33	Queen.	1	6	1	6	3	6	2	14	12	4	23	11	3	1	6	8	17	0	10	0	81	8
34	Early Smooth	1	15	1	15	2	3	2	4	10	14	30	5	6	0	5	15	19	10	7	12	88	13
35	Prize Taker	4	12	7	13	1	14	2	1	21	2	27	9	2	9	4	14	16	14	10	8	100	0
36	Stone	.....	.....	.....	.....	1	15	2	14	12	0	31	6	4	13	5	9	17	0	13	12	89	5
37	Buckeye State	.....	.....	.....	.....	0	7	0	9	2	9	25	8	6	7	15	4	37	4	14	8	102	8
38	Perfection	0	11	.....	.....	1	14	2	3	9	8	26	4	2	14	7	13	19	9	2	14	73	10

TABLE II.—Unsprayed, 1896.

Plot No.	Varieties.	DATE OF AND YIELD AT EACH PICKING.																					
		Aug. 18.		Aug. 22.		Aug. 26.		Aug. 29.		Sept. 7.		Sept. 16		Sept. 19.		Sept. 24.		Oct. 2.		Oct. 16.		Total.	
		Lbs.	Oz.	Lbs.	Oz.	Lbs.	Oz.	Lbs.	Oz.	Lbs.	Oz.	Lbs.	Oz	Lbs.	Oz.	Lbs.	Oz.	Lbs.	Oz.	Lbs.	Oz.	Lbs.	Oz.
1	Liv. Favorite	0	14	......		2	12	1	11	9	14	27	8	2	1	4	3	5	7	2	4	56	10
2	Golden Queen	......		0	9	0	15	0	14	5	10	11	8	4	8	4	2	15	0	5	3	48	5
3	Michigan Early	1	2	2	3	2	15	2	12	22	9	24	6	1	4	3	12	5	11	1	7	68	1
4	Trophy	......		2	2	0	11	0	6	5	10	23	15	4	14	2	15	4	2	5	6	50	1
5	Liberty Bell	1	4	3	7	4	7	2	9	11	5	33	6	1	15	12	3	11	7	2	14	84	13
6	Atlantic Prize	1	0	1	14	3	11	1	7	10	6	16	10	0	11	2	5	2	6	......		40	6
7	Royal Red	......		3	2	4	5	4	4	10	14	26	3	4	4	5	2	12	8	7	9	78	3
8	Ponderosa	0	6	3	6	3	6	......		11	0	32	10	18	0	2	5	3	6	21	0	60	9
9	Paragon	0	6	4	1	4	1	1	14	14	2	36	1	3	6	5	7	14	0	7	4	90	10
10	Matchless	0	15	2	10	1	7	1	4	14	10	24	0	4	6	2	10	10	8	8	0	70	6
11	Early Acme	4	4	5	0	3	6	2	8	13	2	25	1	2	9	1	10	7	1	1	14	66	7
12	Advance	2	11	4	10	4	12	3	14	22	6	31	13	1	11	1	12	3	2	......		76	11
13	Democrat	0	15	2	1	......		1	10	7	13	21	2	4	0	6	12	13	8	7	8	68	5
14	Autocrat	......		1	1	4	1	1	4	2	9	23	4	1	7	4	8	6	8	9	11	54	5
15	Canada Victor	2	2	6	1	5	9	3	9	32	1	27	8	2	6	2	9	6	2	1	2	89	1
16	Potato Leaf	2	13	7	3	3	4	3	10	13	10	27	6	2	2	5	3	14	4	......		79	7
17	Rose Peach	0	5	1	2	1	14	1	5	11	2	20	1	9	1	6	8	7	0	5	14	64	4
18	Purple Peach	......		0	3	0	13	......		4	4	11	6	4	7	6	2	6	2	5	13	39	2
19	Golden Ball	1	15	1	0	0	13	2	2	8	14	11	4	4	12	7	15	11	9	7	5	57	9
20	Cincinnati Purple	1	15	2	7	1	2	3	7	16	0	23	12	1	6	6	3	13	6	4	10	74	4
21	New Imperial	5	3	3	10	2	15	3	6	24	11	28	6	1	10	3	6	5	14	3	9	82	10
22	Early Ruby	11	4	10	13	13	2	7	3	24	14	12	8	1	0	0	12	0	14	......		82	6
23	Essex Hybrid	3	10	6	10	5	4	3	6	24	0	22	13	0	9	2	2	6	5	......		74	11
24	Acme	2	10	5	9	5	5	1	10	17	2	13	14	0	8	2	4	8	10	......		57	8
25	Beauty	1	15	10	11	3	3	2	4	20	0	14	1	2	2	1	0	5	3	......		60	7
26	Dwarf Aristocrat	2	5	3	1	3	10	3	13	8	6	10	8	1	13	0	11	1	14	......		35	1
27	Dwarf Champion	1	1	5	11	3	9	2	10	5	7	6	8	1	3	0	12	1	7	0	11	28	15
28	Purple Husk	......		......		......		......		......		......		......		......		......		......		......	
29	Golden Husk	......		......		......		......		......		......		......		......		......		......		......	
30	Golden Pear	......		......		......		......		......		......		......		......		......		......		......	
31	Truckers' Favorite	1	0	2	12	3	5	2	11	16	4	13	13	1	0	2	15	6	9	2	14	53	3
32	Ford Hook	4	2	7	13	5	0	5	6	23	1	11	1	0	12	1	12	3	14	0	9	63	6
33	Queen	3	3	5	3	5	0	4	0	20	5	22	12	2	3	1	1	5	12	2	4	71	11
34	Early Smooth	2	3	9	9	5	1	3	7	20	1	16	1	1	11	2	1	8	15	4	6	64	7
35	Prize Taker	3	9	4	6	2	9	1	14	15	2	24	2	0	13	2	5	6	5	1	8	62	9
36	Stone	......		1	8	2	10	1	10	11	3	18	11	4	13	2	1	6	6	6	9	55	7
37	Buckeye State	......		......		1	5	0	4	5	2	25	11	3	12	4	14	11	13	11	3	64	0
38	Perfection	0	15	1	8	1	12	2	7	13	9	24	10	1	14	2	0	8	11	0	12	58	2

TABLE III.—Yield per Acre of Varieties of Tomatoes Sprayed and Unsprayed. 1896.

Plot. No.	Varieties.	Sprayed.		Unsprayed		Difference in Favor of Spraying.	
		Tons.	Bush.	Tons.	Bush.	Tons.	Bush.
1	Livingston Favorite	6.49	216.3	6.16	205.4	.83	10 9
2	Golden Queen	7.75	258.3	5.25	175 3	2.30	83 0
3	Michigan Early	9.58	319.4	7.41	247.1	2.17	72.3
4	Trophy	10.90	363.3	5.45	181.9	5.45	181.4
5	Liberty Bell	11.33	377.8	9.23	307.8	2.10	70.0
6	Atlantic Prize	10.41	347.0	4.39	146.6	6.02	200.4
7	Royal Red	10.95	365.3	8.51	283.8	2.44	81.5
8	Pondorosa	6.19	206 5	6.59	219.8	......	......
9	Paragon	12.12	404.0	9.86	328.8	1.26	75.2
10	Matchless	10.74	358 0	7.66	255.5	3.08	102.5
11	Early Acme	10 76	358.7	7.23	241.1	3.55	117.6
12	Advance	8.74	291.3	8.35	278 3	0.39	13.0
13	Democrat	10 12	337 3	8.25	275.0	1.87	62.3
14	Autocrat	11.11	370.2	5 91	197.1	5 20	173 1
15	Canada Victors	11.22	374 2	9.69	323.1	1.53	51.1
16	Potato Leaf	11.50	383.3	8.64	288 2	2 86	95 1
17	Rose Peach	12 98	432.7	6.99	233 0	5.99	199.7
18	Purple Peach	7.49	266.3	4 25	141.9	3.24	124 4
19	Golden Ball	10 28	342.7	6 95	231 7	4.02	134.0
20	Cincinnati Purple	8 86	295.3	8.08	269.3	.78	26.0
21	Imperial	12.36	412.0	8.99	299.6	3.37	112.4
22	Early Ruby	11.68	389.3	8.97	299.1	2.71	90.2
23	Essex Hybriod	9.96	332.0	8.13	271.1	1 83	60 9
24	Acme	8.62	287.5	6.26	208 7	2.36	78.8
25	Beauty	7.90	263.5	6.57	219.2	1.33	44.3
26	Dwarf Aristocrat	4.02	134 3	3.81	127 1	.21	7.2
27	Dwarf Champion	3.59	119.8	3.14	104.9	.45	14.9
28	Purple Husk	......	......	......	......	......	......
29	Golden Husk	......	......	......	......	......	......
30	Yellow Pear	.....	.....	......	.....	......	......
31	Truckers' Favorite	8.52	284.2	5.78	192,7	2 74	91.5
32	Ford Hook	7.92	264.1	6 95	230.1	.97	34.0
33	Queen	8.87	295.7	7.80	260.2	1.07	35.5
34	Early Smooth	9.67	323.3	7.01	233.9	2.66	89.4
35	Prize Taker	10 88	362.8	6.80	226.9	4.08	135 9
36	Stone	9.71	323.9	6.03	201.1	3.66	122.8
37	Buckeye State	11.15	371.5	6 96	232.3	4.19	139.2
38	Perfection	8.01	267.2	6.32	210.9	1.69	56 3
	Average for thirty-five varieties.	9.52	.....	6.98	......	2 51	......

TABLE IV.—Quantity of Green Tomatoes of Different Varieties on Sprayed and Unsprayed Plots. 1896.

Plot No.	Varieties.	Sprayed.		Unsprayed.	
		Lbs.	Bush.	Lbs.	Bush.
1	Livingston Favorite	19.38	32.3	3.05	5.2
2	Golden Queen	46.82	78.0	11.76	19.6
3	Michigan Early	14.37	23.9	3.70	6.1
4	Trophy	38.72	64.5	8.28	13.8
5	Liberty Bell	26.14	58.4	3.05	5.1
6	Atlantic Prize	2.61	43.4	......	......
7	Royal Red	51.61	86.0	1.59	2.6
8	Ponderosa	22 15	96.9	3.05	5.1
9	Paragon	27.66	46 1	9.58	12.6
10	Matchless	10.89	18.1	9.80	16.3
11	Early Acme	6.97	11.6	......	......
12	Advance	1.96	3.2	8.93	14.9
13	Democrat	33.76	56.2	......	......
14	Autocrat	38.55	64.2	12.41	20.7
15	Canada Victor	5.88	9.8	......	......
16	Potato Leaf	3 28	5.4	......	......
17	Rose Peach	25.48	42.4	5 88	9.8
18	Purple Peach	22.43	37.3	11.76	19.6
19	Golden Ball	30.49	57.4	24.61	41.0
20	Cincinnati	29.62	49.3	4.35	7.2
21	New Imperial	11.11	18.5	4.14	6.9
22	Early Ruby	1.31	2.2	......	......
23	Essex Hybrid	1.74	2.9	......	......
24	Acme	3.27	5.4	......	......
25	Beauty	7.62	12.7	......	......
26	Dwarf Aristocrat	2.39	3.9	......	......
27	Dwarf Champion	1.52	2.5	......	......
28	Purple Husk	......	......	......	......
29	Golden Husk	......	......	......	......
30	Golden Pear	......	......	......	......
31	Truckers' Favorite	6.32	10 5	1.96	3.2
32	Ford Hook	1.96	3.2	1.31	2.2
33	Queen	8.48	14.1	3.70	6.1
34	Early Smooth	8 92	13 2	3.05	5.1
35	Prize Taker	4.14	6.7	1.96	3.2
36	Stone	20.25	33.7	3.92	6.5
37	Buckeye State	13.29	22.1	1.96	3.2
38	Perfection	1 96	3.2	......	......

TABLE V.—Results of Test of Varieties and Treatment for the Prevention of Tomato Blight.

YIELD OF PLOTS SPRAYED WITH BORDEAUX SOLUTION.

Size of Plots, 181½ Square Feet, 1897.

Plot No	Variety.	DATE OF AND YIELD AT EACH PICKING.																									
		Aug. 14.		Aug. 17.		Aug. 23.		Aug. 26.		Aug. 30.		Sept. 4.		Sept. 11.		Sept. 16.		Sept. 20.		Sept. 28.		Oct. 6.		Oct. 27.		Total.	
		Lbs.	Oz.	Lbs.	Oz.	Lbs.	Oz.	Lbs.	Oz.	Lbs.	Oz.	Lbs.	Oz	Lbs.	Oz.	Lbs.	Oz.	Lbs.	Oz.	Lbs.	Oz.	Lbs.	Oz.	Lbs.	Oz	Lbs.	Oz.
1	Atlantic Prize	0	4	0	15	2	0	2	0	6	1	5	11	12	1	9	3	7	3	3	3	2	13	2	9	54	9
2	Prize Winner	0	4	0	11	0	14	2	1	4	2	5	10	11	9	17	10	11	2	3	9	4	4	3	11	65	7
3	Brinton's Best	...	...	...	...	0	1	0	4	0	9	1	12	7	7	19	2	21	12	13	6	3	1	20	10	88	0
4	Favorite	...	...	...	...	...	...	0	4	1	0	5	10	10	8	25	3	11	5	10	5	5	0	13	14	83	2
5	Queen	...	...	...	...	...	...	...	...	0	12	0	14	11	0	16	12	19	4	13	14	3	8	15	3	81	3
6	Stone	...	...	...	...	...	...	...	...	0	9	1	13	13	6	18	4	13	8	10	11	5	3	12	14	76	4
7	Prize Taker	...	...	...	...	0	2	...	...	3	11	7	8	16	0	22	13	13	8	10	12	3	2	19	3	96	11
8	Matchless	...	...	...	...	...	...	...	...	3	3	5	1	15	6	15	14	12	0	9	1	6	9	25	3	92	5
9	Paragon	...	...	...	...	...	...	...	...	3	9	0	12	10	8	19	11	19	2	18	5	4	14	24	1	100	4
10	Royal Red	...	...	...	...	...	...	...	...	1	5	1	8	7	2	13	15	13	9	9	15	6	2	32	3	85	11
11	Perfection	...	...	...	...	0	9	0	9	2	0	1	14	10	6	19	2	18	14	14	8	7	8	27	6	102	12
12	World's Fair	...	...	...	...	0	12	...	...	2	0	1	4	11	4	17	11	18	13	15	2	6	1	30	2	103	1
13	Beauty	...	...	...	...	...	...	...	...	1	12	1	4	6	7	7	12	10	8	11	6	7	5	37	15	84	5
14	Imperial	...	...	...	...	...	...	...	...	1	10	2	4	10	5	23	6	14	1	7	14	9	6	14	15	83	13
15	Golden Queen	...	...	...	...	0	5	...	...	3	10	5	7	11	15	24	1	24	2	16	1	10	2	29	6	125	1
16	Climax	...	...	...	...	0	3	...	...	2	5	5	10	11	0	27	15	17	13	11	2	7	8	20	4	103	12
17	Ford Hook	...	...	...	...	0	10	...	...	2	12	4	14	10	14	19	1	10	8	11	6	8	14	12	14	81	8
18	Mayflower	...	...	...	...	...	...	...	...	0	5	0	14	2	2	14	2	9	12	11	9	7	10	15	8	61	14
19	Dwarf Champion	...	...	...	...	1	0	...	...	2	0	0	15	5	14	11	3	9	8	6	3	3	9	3	8	43	12

TABLE VI.—Results of Test of Varieties of Tomatoes Not Sprayed.

YIELD BY PICKING AND PLOTS.

Size of Plots, 181½ Square Feet, 1897.

Plot No.	Variety.	DATE OF AND YIELD AT EACH PICKING.																									
		Aug. 10.		Aug. 14.		Aug. 17.		Aug. 23.		Aug. 26.		Aug. 30.		Sept. 4.		Sept. 11.		Sept. 16.		Sept. 20.		Sept. 28.		Oct. 6.		Oct. 27.		Total.	
		Lbs.	Oz.	Lbs.	Oz.	Lbs.	Oz.	Lbs.	Oz	Lbs.	Oz	Lbs.	Oz.	Lbs.	Oz.	Lbs.	Oz	Lbs.	Oz.	Lbs.	Oz.	Lbs.	Oz.	Lbs.	Oz.	Lbs.	Oz.	Lbs.	Oz.
1	Atlantic Prize	0	2	0	2	2	8	1	4	4	6	5	6	6	2	1	10	2	1	0	10	0	13	0	0	0	0	35	0
2	Prize Winner	0	3			0	10	2	4	2	15	6	4	13	1	11	0	7	14	2	8	0	9			0	0	47	4
3	Brinton's Best							0	5	0	14	1	2	6	7	11	12	18	8	8	2	4	2	1	15	4	12	57	15
4	Favorite					0	7	0	7	0	15	2	9	5	13	5	7	16	1	7	9	4	1	0	6	4	8	48	3
5	Queen							0	5	1	6	1	12	2	3	10	4	16	5	11	10	3	7	1	8	4	14	53	10
6	Stone							0	4	2	6	1	8	5	10	7	0	16	3	9	12	3	15	1	12	5	8	52	14
7	Prize Taker							0	14	1	7	1	9	7	6	15	14	15	7	5	6	5	0	0	14	7	5	61	2
8	Matchless							0	8	0	14	3	5	5	14	17	1	22	11	9	12	9	4	4	10	18	12	92	11
9	Paragon							0	7	1	8	1	7	6	6	15	5	29	14	13	9	7	14	3	8	17	2	97	0
10	Royal Red									1	7	2	1	2	3	6	15	22	10	14	14	8	7	6	11	27	5	92	9
11	Perfection							0	2	1	0	1	10	2	8	6	6	23	4	11	2	9	2	8	1	13	4	73	7
12	World's Fair							0	2			3	8	7	3	10	1	23	6	14	10	10	9	7	12	29	7	87	5
13	Beauty							0	2	2	6	0	12	1	13	11	15	19	0	10	15	7	5	5	2	14	9	73	15
14	Imperial							0	12	2	10	3	12	2	11	10	7	21	9	11	14	4	0	1	13	2	11	62	3
15	Golden Queen							0	14	1	12	2	9	6	10	16	0	32	2	12	2	6	8	4	3	8	8	91	4
16	Climax							0	9	0	15	2	7	6	4	10	9	20	0	13	1	3	14	4	4	10	2	72	1
17	Ford Hook							1	10	2	8	2	12	7	4	12	2	23	5	10	9	5	2	3	1	3	2	72	7
18	Mayflower									0	11	1	8	1	6	5	13	25	7	8	6	8	10	8	5	12	4	72	6
19	Dwarf Champion							1	3	0	13	2	5	5	8	7	0	9	2	3	8	1	5	0	10	0	7	31	13

TABLE VII.—Yield per Acre of Varieties of Tomatoes Sprayed and Unsprayed. 1897.

Plot No.	Varieties.	Sprayed.		Unsprayed.		Difference in Favor of Spraying.	
		Tons.	Bush.	Tons.	Bush.	Tons.	Bush.
1	Atlantic Prize	6.54	218.0	4.20	140.0	2.34	78.0
2	Prize Winner	7.84	261.6	5.66	188.8	2.18	72.8
3	Brinton's Best	10.55	351.9	6.97	232.4	3.58	119.5
4	Livingston's Favorite	9.97	332 4	5.85	195.1	4.12	137.3
5	Queen	9.74	324.7	6.43	214.4	3.31	110.3
6	Stone	9.14	304.7	6.34	211.5	2.80	93.4
7	Prize Taker	11.60	386.9	7.33	244.3	4.27	142.6
8	Matchless	11.07	369 2	11.12	370.8	......	......
9	Paragon	12 02	400.8	11.63	387.9	0.39	12.9
10	Royal Red	10 22	340.8	11.11	370.3	......	......
11	Perfection	12.33	411.1	8.80	293.6	3.53	117.5
12	World's Fair	12 44	414.8	12.78	426.0	......	......
13	Beauty	10.11	337.2	8.86	295.5	1.25	41.7
14	Imperial	10.05	335 1	7.45	248.4	2.60	86.7
15	Golden Queen	15.01	500.4	10.94	364 7	4.07	135.7
16	Climax	12.44	414.8	8.65	288.4	3.79	126.4
17	Ford Hook	9.78	326.0	8.65	288.4	1.13	37.6
18	May Flower*	8.90	296.7	8.68	289 2	0.22	7.5
19	Dwarf Champion	5.25	175.2	3.86	127.2	1.39	48.0
	Average of nineteen varieties	10.26	......	8.11	......	2.15	......

*Yield corrected for one plant missing in the sprayed portion.

TABLE VIII.—Quantity of Green Tomatoes of the Different Varieties on the Sprayed and Unsprayed Plots. 1897.
(Calculated in Pounds and Bushels per Acre.)

	Varieties.	Sprayed.		Unsprayed.	
		Lbs.	Bush.	Lbs.	Bush.
1	Atlantic Prize	5.04	8.4	......	......
2	Prize Winner	7.68	12.8	.....	... .
3	Brinton's Best	24.48	40.8	15.12	25.2
4	Favorite	17.04	28.4	12.24	20.4
5	Queen	21.12	35.2	7.20	12.0
6	Stone	23.52	39.2	19.20	32.0
7	Prize Taker	14.64	24.4	15.12	25.2
8	Matchless	36 00	60.0	19.68	32.8
9	Paragon	29.04	48.4	20.40	34.0
10	Royal Red	54.96	91.6	36.24	60.4
11	Perfection,	17.04	28.4	22.80	38.0
12	World's Fair	54.24	90.4	24.00	40.0
13	Beauty	45.60	76.0	12.48	20.8
14	Imperial	20.40	34.0	21.84	36.4
15	Golden Queen	30.00	50.0	17.04	28.4
16	Climax,	8.88	14.8	20 16	33.6
17	Ford Hook	4.56	7.6	4.80	8.0
18	Mayflower	17.76	29.6	13.68	22.8
19	Dwarf Champion	......	......	......	... ..

TABLE IX.—Average Results of Spraying of Varieties Tested Two Years. (*Yields per Acre.*)

	Varieties.	1896.		1897.		Average.	
		Sprayed.	Not Sprayed	Sprayed.	Not Sprayed.	Sprayed.	Not Sprayed.
		Tons	Tons.	Tons	Tons.	Tons.	Tons.
1	Favorite	6.49	6.16	9 97	5.85	8.23	6.00
2	Golden Queen	6.98	5.25	15.01	10.94	10.99	8.09
3	Atlantic Prize	10.41	4.39	6.54	4.20	8.47	4.29
4	Royal Red	10.95	8.51	10.22	11.11	10.58	9.81
5	Paragon	12.12	9.86	12.02	11.63	12.07	10.74
6	Matchless	10.74	7.66	11 07	11.12	10.90	9.39
7	Imperial	9.89	8.99	10.05	7.45	9.97	8.22
8	Beauty	7.90	6 57	10.11	8.86	9 00	7.71
9	Dwarf Champion	3.59	3.14	5.25	3.86	4.42	3.50
10	Ford Hook	7.92	6.95	9.78	8.65	8.85	7.80
11	Queen	8.87	7.80	9.74	6.43	9 80	7.11
12	Prize Taker	10.88	6.80	11 60	7.33	11.24	7.06
13	Stone	9.71	6.03	9 14	6.34	9.42	6.18
14	Perfection	8 01	6 32	12 33	8.80	10.17	7.56

ERRATA:—There should be no decimal point in the pound columns in tables 4 and 8.

On page 125, lines 12 and 17, read "6 lbs.," instead of "8 lbs."

Page 118, line 18, "statement" should read "State."

[illegible]

Bred

[illegible] of [illegible]
[illegible]
plant [illegible]
[illegible]
symptom [illegible]
Disease
How these may be control
[illegible] of [illegible]

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MARYLAND

Agricultural Experiment Station.

BULLETIN NO. 55.

The Black Peach Aphis—Cut Worms in Young Tobacco—Law Providing for the Suppression and Control of Insect Pests and Plant Diseases in Maryland.

College Park, Md.

MAY, 1898.

MARYLAND
Agricultural Experiment Station.

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NOTICE.

The bulletins of the Station will be mailed free to any citizen of Maryland who sends his name and address to the Station for that purpose.

Correspondents will please notify the Director of changes in their post-office address, or any failure to receive the bulletins.

ADDRESS,

MARYLAND AGRICULTURAL EXPERIMENT STATION,
COLLEGE PARK, MD.

The Black Peach Aphis—Cut Worms in Young Tobacco—Law Providing for the Suppression and Control of Insect Pests and Plant Diseases in Maryland.

By W. G. Johnson, Entomologist.

THE BLACK PEACH APHIS

(Aphis prunicola Kalt.)

The black peach aphis has made its appearance in certain sections of the State in such unusual numbers, we have deemed it expedient to embody an account of it in this bulletin, calling especial attention to it. Great injury is being done to the unfolding buds in nurseries, and to young trees set out this spring and last fall. In one instance the pest is in a single block of peach in which over a million seedling were budded last season. At another place a block of five hundred thousand trees are being seriously damaged. I was called to this nursery by telegram, April 20th, and upon examination found that considerably over one hundred thousand young trees, where the buds were just starting, were literally covered with the insects. The creatures were clustered upon the young shoots, to such an extent that the rows looked as if they had been dusted with lamp black. The general appearance of one of these young trees is shown in figure 1, at *a*. The insects are so thickly clustered upon the young shooting bud, it can scarcely be seen. A normal bud, as it should be, is shown at *b*. A leaf with the insects on the under surface is shown at *c*. A correspondent from Washington County says in a letter April 21st, that he is having a great deal of trouble with this insect on peach planted this spring and upon plum set out one year ago.

Nature of the Attack.—The ravages of this pest in the past have been very great, and I hope this circular will be timely warning to many nurserymen and orchardists who might otherwise suffer considerable loss. Trees badly attacked by this insect are very conspicuous even at a distance. The leaves are yellowish, more or less clustered, many of them being curled and spotted. The result is that the tree is dwarfed and stunted; and in the case of young buds in the nursery, they are killed outright in a very

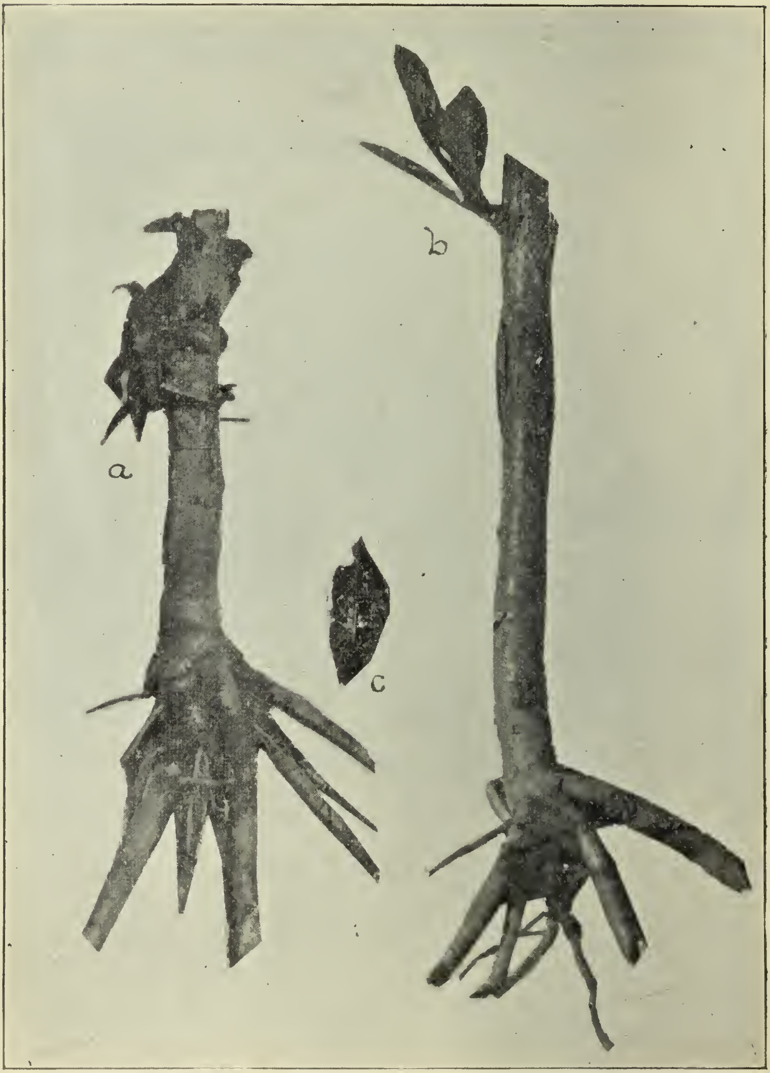

Fig. 1.—Injury to young peach buds. *a*, bud covered with black peach aphis; *b*, normal bud; *c*, leaf with insects on under surface. (Original.)

few days. The insect is sometimes called the black peach louse, and if a cluster of them is examined, winged and wingless individuals, and young from the newly born in all stages to the adult, will be seen. One of the wingless viviparous forms is shown at figure 2. There may also be seen in the same colony many winged forms as shown in figure 3. The young of these insects are produced alive and unlike most other plant lice, they spend part of their time upon the roots in the ground, retiring about midsummer and remaining below the surface until the following spring.

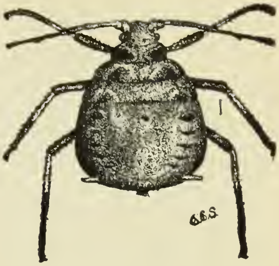

Fig. 2.—Common Wingless Female of the Black Peach Aphis. (After Slingerland).

Remedial Measures.—Of the remedial measures suggested and tried I have found kerosene emulsion the most effective. The degree of success attained will depend (1) upon the completeness of the emulsion, (2) the kind of apparatus used for applying it, and (3) the thoroughness of the spraying.

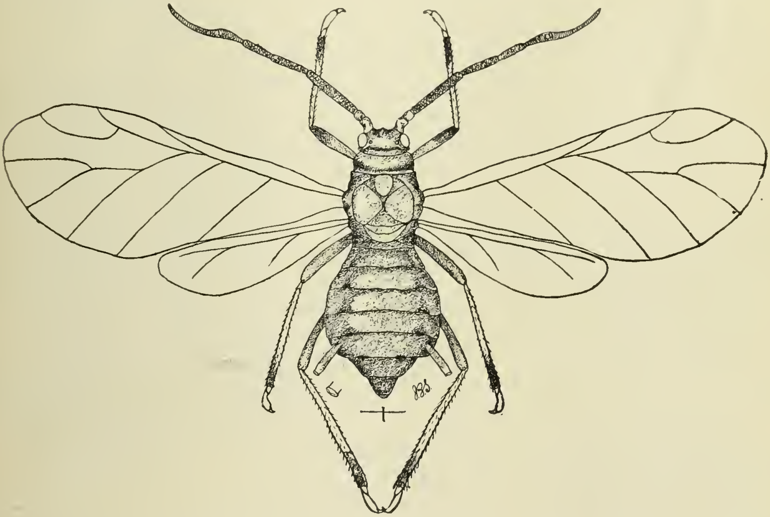

Fig. 3.—Common Winged Female of the Black Peach Aphis. (After J. B. Smith.)

Kerosene emulsion must be made explicitly according to the directions as oil and water will not mix by stirring, or by pouring from one vessel to another. It is made as follows:—

Hard (or soft) soap (ivory soap preferable)......	½ pound.
Water (rain water if convenient)..............	1 gallon.
Kerosene (common coal oil)..................	2 gallons.

Put the water in a vessel holding four or five gallons, add the soap by shaving it into thin pieces, place on a stove and bring to the boiling point, occasionally stirring it to thoroughly dissolve the soap; then remove to the yard, or some convenient place away from the fire, and pour the kerosene directly into the water. This should then be pumped in and out of the vessel with a good force pump for from five to ten minutes or until the emulsion is formed. If properly made, it will have the appearance of buttermilk, and will readily mix with water without any oil coming to the surface. It will keep an indefinite length of time, becoming a semi-solid when cold. If used when fresh it can be diluted with cold water to the strength desired; but if cold and hard, warm water should be used. Every gallon of the emulsion used should be diluted with from 10 to 12 gallons of water, and applied with a good spray pump.

There is now upon the market a spraying apparatus which mechanically mixes kerosene with water, and does away with the seemingly troublesome method, although it is very simple in practice, of making the emulsion by hand. There are several styles of these machines, one is made so that it can be used in any ordinary pail and and costs about $7.00. The Knapsack costs about $14.00, and the barrel as shown in figure 4, about $16.00. I have found these sprayers the most satisfactory I have ever used in combatting plant lice. To operate figure 4, it is only necessary to fill the tank with pure kerosene, the barrel with clean water, set the indicator at the figure giving the percentage desired and everything is in readiness. From a series of tests made with one of these sprayers, April 21st, 1898, we have found that 15 per cent. kerosene and water gave us the most satisfactory results. The tests ranged from 5 to 30 per cent.

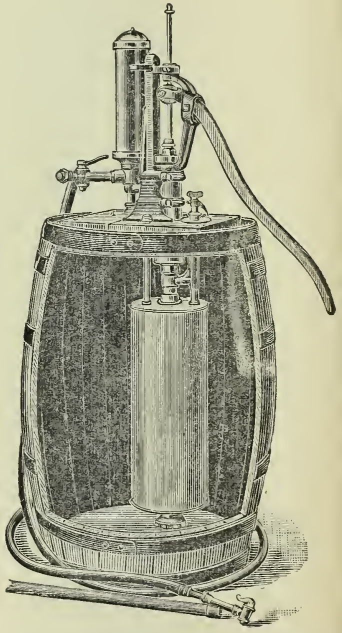

Figure 4.—The Peerless Kerosene Sprayer. (After The Deming Co.)

Where only a few branches of small one year old trees are found infested it would be wise to cut them off and burn them. If for any reason it is desired to save them, the branches should be bent over and dipped in a soap solution at the rate of 1 pound of soap to 7 gallons of water. An efficient and cheap mixture can also be made by soaking 8 to 10 pounds of home-grown tobacco leaves and stems in 40 gallons of water for two days (48 hours). Dissolve 2 pounds of whale oil or soft soap in a gallon of hot water, add to the barrel of tobacco infusion, stir thoroughly and apply with a good spray pump or dip the infested branches in it.

For a more detailed account of some common injurious plant lice, with suggestions for their destruction, See Bulletin 48 of the Maryland Agricultural Experiment Station, a copy of which will be sent upon application.

CUT WORMS IN YOUNG TOBACCO.

For many years the tobacco growers of Maryland have suffered serious annual loss from the ravages of cut worms. These losses are becoming more apparent in sections where crimson clover and other crops are grown on the tobacco lands for turning down in the spring as a soil crop. Such fields furnish ideal places, the early and latter part of the season, for the parent insects to deposit their eggs and for the young worms to feed. The result is, that when the crop is turned under, the worms remain below the ground for a time feeding upon the leaves, stems and roots, until the tobacco plants are set out, and then they emerge from their subterranean hiding places and concentrate their attacks upon the delicate plants. The damage thus done is very great as it necessitates replanting, and in many instances, the second planting is cut off. Consequently, the grower is not only annoyed by worms but the unevenness of his crop is very noticeable, and causes much trouble and extra expense in handling as it does not ripen uniformly.

For the past two seasons this office has received many inquiries regarding these insects, and anticipating similar requests for information this spring, we have thought it wise to issue these notes with suggestions for the general information of tobacco growers.

Generalized History.—The caterpillars or worms, commonly called cut worms are the young of a great family of night flying moths known as Noctuids. The moths are rarely ever seen in the day time, and dart here and there when disturbed. They hide during the day in grass and weeds, under stones and rubbish of all kinds, in fact, any place where they can find shelter. Many of them exhibit remarkable instances of protective coloration and can only be detected by very careful observation.

They are very active at night and certain species are attracted to lights in great numbers. They also have a special liking for sweets, and entomologists make use of this peculiar habit, catching them for study, by painting fence boards, trees, etc., with a mixture of molasses and stale beer. Thus many species are trapped and caught that it would be difficult to get otherwise.

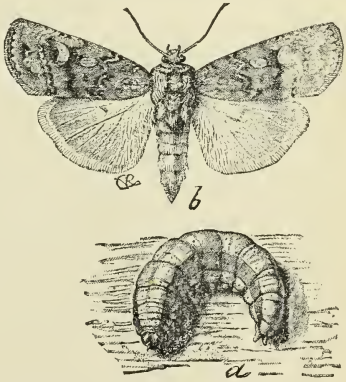

Fig. 5.—Dark-sided Cut Worm, *Agrotis messoria*, Harr. *a*, larva; *b*, adult moth. (After Riley.)

The parent insects or moths of the common cut worms, are seen almost daily or nightly by the tobacco grower, but they are not usually recognized as the progenitors of the destructive worms. The moths vary greatly in color in the different species, and usually have a wing expanse of from an inch and a half to two inches as seen by the accompanying illustrations. Normally, the female lays her eggs in grass lands, but clover fields and weedy places get their share. The female will deposit her eggs most any place where the ground is densely covered with vegetation. The eggs are rarely ever laid on or in the ground, but are frequently found on trees, stones, or leaves.

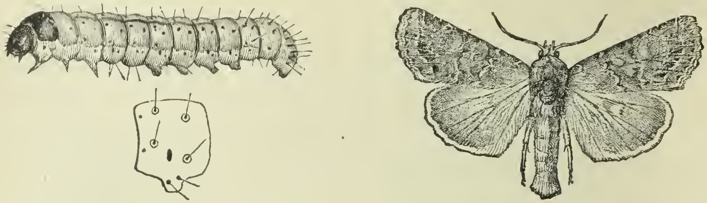
Fig. 6.--Glassy Cut Worm, *Hadena devastatrix*, Brace. (After Riley.)

The young worms hatching from these eggs early in the summer or late fall, feed voraciously upon any vegetation in their vicinity, and are by no means, particular what it is; the only requirement being that the plant shall be juicy and abundant. Many worms of certain species reach about half their growth when winter sets in. They remain in the ground until the following spring and then renew their feeding with great activity. Some varieties assume a climbing habit and cut leaves and twigs of young trees and shrubs, and are therefore called "climbing cutworms." This climbing tendency is rarely exhibited where there is an abundance of vegetation on the ground.

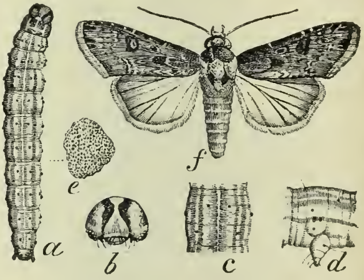

Figure 7.—Shagreened Cut Worm, *Feltia malefida*, Guen. (After Riley.)

When fully grown the worms vary in length from one to two inches or more. They also vary greatly in color and different species are usually easily recognized at a glance. For instance, the one shown at figure 5, is known as the dark sided cut worm, on account of the dark stripes extending along the sides of its body. For a similar reason, the one shown in figure 6 is known as the glassy cut worm, and the one in figure 7 as the shagreened cut worm, while figure 8 is called granulated cut worm.

One of the commonest forms we have in Maryland, especially in the tobacco growing counties, is known as the greasy or black cut worm. Another very common species in this State is known as the variegated cut worm. When these caterpillars reach maturity they enter the ground usually just below the surface and transform into what is known as the pupa or quiescent stage. A pupa of the granulated cut worm is shown in figure 8 at *f*. After remaining in this condition for a few days in midsummer the adult or parent moth emerges and is ready to deposit the eggs for the next brood in some suitable place.

It must be said in this connection that this is only a generalization of the life history of this destructive group of insects, and will apply to a large number of species. Some of them vary considerably in habits and mode of transformation. Some live over winter in the adult stage, while others remain in the larva or pupa condition during that time. But in some instances we have found both the adult, nearly full grown larva and pupa, during the winter. Some species are double brooded, that is, there are two distinct broods during the same season, while others have but a single brood.

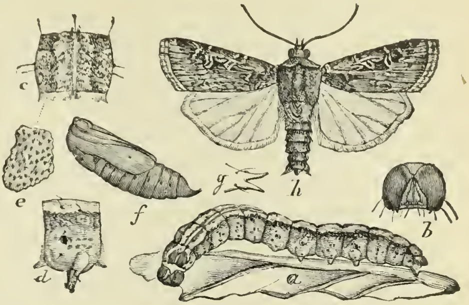

Fig. 8.—Granulated Cut Worm, *Feltia annexa*, Treits. (After Riley.)

The adults of the cut worms usually found in our tobacco fields appear generally during the month of July. The parent moth of the greasy cut worm (*Agrotis ypsilon*) began emerging in my breeding cages here July 19th, 1897. The worms were found abundant in tobacco fields the latter part of May and early June, doing considerable damage to the young plants. I also bred the adult from another species found in tobacco, known as the variegated cut worm (*Peridroma saucia*). The first moth appeared July 2nd, 1897.

Assuming that these general remarks will suffice to answer the queries usually asked rgarding cut worms, we will now turn our attention to the remedial measures.

Remedial Measures. —Many suggestions have been made, and many remedies tried for the destruction of cut worms, but none of them have given such marked and promising results as the poison bait. One year ago the remedy for the destruction of the cut worm was under discussion at the "Farmer's Club" at Bel Alton, Charles Co., and I was asked by the President of that organization, Samuel Cox, Jr., to prepare a reply to the query, and submit it to be read at their regular meeting. This paper was written March 15, 1897, read at their April meeting, and published in the County papers. As a result many farmers used the remedy suggested with gratifying results.

We know that the worm, as well as the adult moths, have a liking for sweet substances, and are attracted to them when they are placed in their vicinity. We also know that the worms eat wheat bran, with much relish. By combining, therefore, the bran with molasses, or syrup made from sugar, we have an ideal bait, and the worms will eat it in preference to anything else when it is available. By poisoning this material with Paris green or arsenic we have a good remedy, cheap and easy to apply.

The ingredients used for making the poison mash are as follows:

Wheat bran	50 lbs.
Molasses (any kind)	2 quarts.
Paris green (good quality)	1 lb.
Water (enough to make thick mash)	

The bran should be placed in an old tub or barrel, and to this the Paris green should be added and stirred thoroughly with a shovel or other implement before the water or molasses is poured in. Stir the molasses in about a gallon of warm water and pour it over the bran and Paris green, thoroughly stirring until it is well mixed. Then add enough water to maks a mash about the consistency of dough, so that it can be handled easily without running.

The material having been prepared it is now ready to be applied, and to do this successfully, several essentials are necessary.

(1) The land should be prepared several days in advance.

(2) After the drills are made, a pinch of poison mash, about as much as one could hold on a table spoon, should be dropped in the vicinity (*not in the exact place*) of the spot where the plant will be set. This should be done from *three* to *five* days before the plants are put out.

(3) The application should be made in the afternoon as near evening as practicable; but where it is necessary, in order to get over large areas, there is no objection to dropping it in at time during the day.

(4) Care should taken to keep chickens, turkeys, or animals of any kind that would be liable to eat the mash, out of the field for a day or two, or until after the tobacco is set.

This remedy is so simple and inexpensive, there is no good reason why the farmers of this State should loose so heavily each season from the attacks of these worms. The remedy can also be applied to any other plants or crop that is attacked by cut worms. It can be used to good advantage by onion, tomato and cabbage growers.

One of my correspondents, Henry C. Adams, of Mechanicsville, St. Mary's County, one of the largest and most successful tobacco growers in Maryland, who used this remedy last year writes me February 8th, as follows:—

"Last spring, a few weeks before planting my tobacco, I noticed in a Charles County paper, a remedy suggested by you, for the extermination of cut worms. I adoped it and the results were first class. After preparing the drills I applied a small quantity of the preparation suggested by you, near the place where the plant was to be set. The cut worms readily came up, ate it, and were killed before the planting of the tobacco. There would often be five or six dead worms lying on a hill, and I had no trouble, whatever, in getting a good stand of tobacco. Without the remedy, I do not believe I could have gotten a stand at all, with the number of worms in the ground. At any rate, the crop would not have been uniform. The remedy is inexpensive and not to be compared with the expense and bother of replanting, which I consider one of the most aggravating and life destroying jobs done on a farm. The suggestions made by you is worth a great deal to me, and supplies a need which the farmers have been wishing for so long."

THE NEW LAW PROVIDING FOR THE SUPPRESSION AND CONTROL OF INSECT PESTS AND PLANT DISEASES IN MARYLAND.

On account of the serious ravages of certain insect pests and plant diseases which have greatly interfered with the horticultural, agricultural and nursery interests of this State, it was deemed wise and expedient by those whose interests were represented, that they ask the State to make provision for the establishment and support of a department which should subserve their interests along certain lines.

The bill which follows, was therefore, the outcome of a convention which convened in Baltimore, January 26 and 27, 1898. The subject was carefully considered from the standpoint of the horticulturist, agriculturalist, nurseryman, trucker, florist, and from the practical and scientific sides.

The measure provides for the creation of a State Horticultural Department, which is under the immediate control of the Board of Trustees of the Maryland Agricultural College and Experiment Station. The State officers, whose duties are specifically designed, are professors of their respective departments, entomology, pathology and horticulture in the College and Station. Aside from their work as teachers and experimentors, the entomologist and pathologist, are required to ascertain, by inspection, the general horticultural and agricultural condition prevailing in each county each year; and must inspect each nursery every six months. These officers are given full police power to enter upon any land in the State for purposes of inspection or experimentation.

It is unlawful for any transportation company, person, or firm to deliver any kind of nursery stock to any person within this State, unless it is first covered by a certificate of inspection. The penalties attached for the violation of this law are severe.

It is not the intention of the officers charged with execution of this Act, to enforce its provisions for any selfish motives; but in view of the fact that our own orchardists, agriculturalists and nurserymen must submit to the provisions bearing directly upon their interests, we feel justified in saying that we expect those outside our State, doing a nursery business within our territory, to respect our wishes, and co-operate with us in the suppression and control of these pests so far as is practicable.

The departments are now being thoroughly equipped for the prosecution of the work to the very best advantage. Whenever it is practicable the apparatus belonging to these departments will be taken to various places in the State whenever an emergency arises. The officers will give as much time and personal attention to each important outbreak of insect or disease as the funds and assistance at their disposal will permit.

It is the desire of the officers of this department to keep in touch with the people of the State on topics of economic importance and all inquiries will be given prompt and considerate attention. If there is an outbreak of any insect or disease in your vicinity, or an insect or diseased leaf or plant about which you desire information, enclose it in a small box or envelope to our address. Co-operation is necessary to get the greatest possible benefit out of this work. It will be impossible for the State Officers to know the exact conditions over the entire State at any one time, unless those for whose interest this department was created, keep them posted. For the benefit of the general public we append herewith, an exact copy of our State law.

LAWS OF MARYLAND, 1898.

CHAPTER 289.

An Act to repeal Sections 51, 52, 53, 54, 55, 56, 57 and 58 of Article XLVIII of the Code of Public General Laws, title "Inspections," sub-title, "Trees and Nursery Stock," as designated by Chapter 290 of the Acts of the General Assembly of Maryland of 1896; and to re-enact the same with amendments, under a new sub-title, to be known as "State Horticultural Department," and to add thereto eight new sections, to be designated 59, 59 A, 60, 61, 62, 63, 64 and 65, providing for the protection of the horticultural interests of the State by the suppression and extermination of the San Jose scale, peach yellows, pear blight and other injurious insect pests and plant diseases; and to create the offices of "State Entomologist," "State Pathologist," and "State Horticulturalist," and to appropriate a sum of money therefor.

SECTION 1. BE IT ENACTED BY THE GENERAL ASSEMBLY OF MARYLAND, That sections 51, 52, 53, 54, 55, 56, 57 and 58, of Article XLVIII of the Code of Public General Laws, title "Inspections," sub-title, "Trees and Nursery Stock," as passed by the General Assembly of Maryland, session 1896, be and the same are hereby repealed and re-enacted to read as follows:

51. That a State Horticultural Department be established for the State of Maryland; that its purpose is to suppress and eradicate the San Jose scale, peach yellows, pear-blight, and other injuriously dangerous insect pests and plant diseases throughout the State of Maryland.

52. That the Professor of Entomology, the Professor of Vegetable Pathology, and the Professor of Horticulture of the Maryland Agricultural College and Experiment Station shall be the State Entomologist, State Pathologist and State Horticulturalist, respectively.

53. That the said Horticultural Department shall be under the control of the Board of Trustees of the Maryland Agricultural College and Experiment Station, to whom the officers created under this Act shall be responsible; that the salary of the State Entomologist and State Pathologist shall be fixed by the said Board of Trustees, and the said Board shall likewise fix the compensation of any assistant or assistants, employee or employees, and control all expenses thereof. That the expenses of said department shall be paid out of an appropriation hereinafter provided for, and that said Board of Trustees be invested with all powers necessary to carry into effect the provisions of this Act; but no expenses shall be incurred beyond the amount appropriated.

54. That it shall be the duty of said State Entomologist and State Pathologist, their assistants and employees, under the control of Trustees of said College, to seek out and suppress all pernicious insect pests and contagious diseases hereinbefore mentioned as destructive to the horticultural and agricultural interests of this State, and conduct experiments when necessary to accomplish that end.

55. That in order to accomplish the purposes of this Act, the State Entomologist and the State Pathologist, their assistants and employees, or any other officer, assistant or employee appointed by said Board of Trustees, are hereby authorized to enter upon

any public premises, parks, cemeteries, or other premises, or upon any land of any firm, corporation or private individual within the State of Maryland, for the purpose of inspecting, destroying, treating or experimenting upon the insects and diseases aforesaid. Should any insect or disease found by said State Entomologist or State Pathologist, or by any other officer appointed by said Trustees, be, in their opinion, capable of eradication without the destruction of the tree or plant, then said officers are to treat or cause to be treated with proper remedies and appliances all such trees, vines, shrubs, plants and grains. Further, said State officers shall treat or have treated, in order to prevent the dissemination of the aforesaid insects or diseases, any and all suspicious trees, vines, shrubs, plants and grains found to be in a dangerous proximity to those infested as aforesaid. ,

56. That should any of the officers aforesaid, through their assistants and employees, or by any notification whatsoever, find any fruit trees, vines, shrubs, plants or grains infested or diseased with the aforesaid insects or diseases, the aforesaid officers shall mark or tag in some conspicuous way all trees, vines, shrubs, plants or grains infested with the aforesaid diseases, and shall give notice in writing to the owner or owners, tenants or person in charge of such premises of the condition thereof, and thereupon, if such person or persons so notified shall not within ten (10) days after notification, destroy or treat the same in accordance with regulations and rules of said Trustees, a copy of which will be sent on application to any person, then said Trustees shall, through their officers, assistants or employees, destroy or treat all such trees, plants, vines, shrubs and grains, and the State officers shall file a statement of the expenses of such destruction or treatment with the Trustees of said College, and said Trustees shall transmit a copy of such statement and account of such expenditure, with the usual affidavit attached thereto, to be made by the State officers, which shall be sufficient evidence to prove the claim to the State's Attorney of the county where the owner of such premises resides, and said Attorney is directed to collect the same and account to the Trustees of the Maryland Agricultural College therefor.

57. That it shall be the duty of said Trustees to send the State Entomologist, or the State Pathologist, or their duly authorized assistants, at least once a year into each county of the State for the purpose of determining by inspection the healthfulness and general condition of the horticultural and agricultural interests.

58. That it is hereby also made the duty of the said Board of Trustees, through the State Entomologist, and the State Pathologist, or their duly authorized assistants, to inspect at least once in every six (6) months all nurseries, of trees, vines, shrubs and plants, subject to the aforesaid insects or diseases, within the State, and if found free, so far as can be determined by inspection, from the aforesaid insects or diseases, to give to the owner or owners, or persons in charge of said nurseries, a certificate of inspection, showing such nurseries or premises to be apparently free from such insects and diseases. If any of the aforesaid insects or diseases should be found in any nursery or orchard, or any premises within the State where nursery stock is grown, the aforesaid officers shall cause to be destroyed or treated such portion of such nursery stock, or other trees or plants, as in their opinion may be necessary, and shall release all other nursery stock grown upon said premises, and issue a certificate of inspection to the owner or owners, as herein provided for; and if such infested or diseased trees, vines, plants or shrubs, be destroyed by the aforesaid officers, then the owners shall pay the cost thereof, and if he refuse to pay the same, it shall be collected as prescribed in Section 56. No nurseryman, broker, agent, dealer or other person shall be permitted to sell, ship, send out, or give way, by mail, express, freight, or otherwise, any trees, vines, shrubs, plants, buds or cuttings from any such nurseries or premises, without accompanying the same, with a copy of the said certificate printed upon a tag or label, not easily destroyed,, the same to be firmly attached in some conspicuous position upon each car-load, box, bale or package so sent out or delivered.

SECTION 2. AND BE IT ENACTED BY THE GENERAL ASSEMBLY OF MARYLAND, That the following sections be and the same are hereby added to Article XLVIII of the Code of Public General Laws, title "Inspections," sub-title "Horticultural Department," to be designated as Sections 59, 59 A, 60, 61, 62, 63, 64 and 65.

59. That should any nurseryman, agent, broker, dealer or other person send out or deliver within the State, or transport to any other State or Territory, or the District of Columbia, trees, vines, shrubs, plants, buds or cuttings, subject to the attacks of insects and diseases above provided for, without attaching a copy of said certificate, deface or destroy said certificate, or wrongfully attach a certificate, he shall be adjudged guilty of a misdemeanor, and shall, upon conviction, before any Justice of the Peace, be fined a sum not less than ten dollars ($10.00) or more than one hundred dollars ($100.00) and costs of prosecution for each and every offense, and stand committed until such fine and costs are paid, and the fines so collected shall be paid to the Trustees of the said College, and be added to the funds herein provided for carrying out the provisions of this Act.

59 A. That all trees, plants, vines, shrubs, buds or cuttings, commonly known as nursery stock, grown or handled by each and every nurseryman within this State, and subject to the attacks of the aforesaid insects or diseases, shall be fumigated by the nurseryman owning the same, with hydrocyanic acid gas in buildings or enclosures inspected and approved by the aforesaid State officers, under their direction.

60. That when any trees, plants, shrubs, vines, buds or cuttings, commonly known as nursery stock, are shipped into this State from any other State or Territory, or the District of Columbia, to any nurseryman, broker, dealer, agent or other person in this State, every car-load, bale, box or package thereof, shall be plainly labeled on the outside with the name of the consignor, the name of the consignee, and a certificate showing that the contents have been inspected by a qualified State or government officer, and that the trees, plants, vines, shrubs or cuttings therein contained are apparently free from the insects and diseases herein provided for. Whenever any trees, plants, vines, shrubs, buds or cuttings are shipped into this State from any other State or Territory, or the District of Columbia, without such certificate plainly fixed on the outside of each car-load, box, bale or package, the agent of the transportation company, firm or person receiving same, shall not deliver said nursery stock to the consignee or agent representing the consignor, and said agent of the transportation company, firm or person, shall notify the State Entomologist or State Pathologist, at the Maryland Agricultural College, and the State officer receiving such notification shall immediately notify any Justice of the Peace of this State to issue a summons for the consignee, and the agent or consignor, if he be known, of such car-load, box, bale or package of nursery stock, to appear before him, on a certain day to be named herein, to show why such trees, plants, vines, shrubs, buds or cuttings should not be seized as being in violation of the provisions of this Act, and on trial thereof, if said Justice be satisfied that the provisions of this Act have been violated, said Justice shall order said agent, or consignee, to return such car-load, box, bale, package of trees, plants, shrubs, vines, buds or cuttings immediately to the shipper or consignor, unless said consignee, or agent of the consignor, at his expense, shall forthwith have said nursery stock examined by the State Entomologist and State Pathologist of this State, and such officers certify to such Justice of the Peace that said nursery stock is apparently free from the insects and diseases mentioned herein, and tag every such car-load, box, bale and package inspected by said officers, with their certificate of inspection, and if said agent or consignee shall fail to have said nursery stock examined by said State officials, or fail to return such car-load, box, bale or package thereof, then said Justice of the Peace shall order and direct the sheriff or constable to burn and destroy all such trees, plants, shrubs, vines, buds or cuttings that have been shipped into this State in violation of this Act.

61. That whenever any agent of a transportation company, firm or person, shall receive a car-load, box, bale or package of trees, plants, shrubs,

vines, buds or cuttings, without a certificate attached, as provided for in Section 60 of this Act, and shall fail to notify the State Entomologist or State Pathologist of this fact, immediately upon the arrival of such nursery stock, and before delivering the same to the consignee, said agent of the transportation company, firm or person, shall be adjudged guilty of a misdemeanor, and shall, upon conviction, before a Justice of the Peace, be fined a sum not less than ten dollars ($10.00) nor more than one hundred dollars ($100.00), and costs of prosecution for each and every offense, and stand committed until such fine and costs are paid, and the fines collected shall be paid to the Trustees of said College, to be added to the fund herein provided for, carrying out the provisions of this Act. If any nurseryman, dealer or agent, sell, ship or deliver any trees, plants, shrubs or vines, into this State which are infested with San Jose scale, peach-yellows, pear blight or other injuriously dangerous insects or diseases, and upon examination by the State Entomologist and State Pathologist, or their assistants, are condemned as being so infested, the said trees, plants, vines and shrubs shall be destroyed, and the nurseryman, dealer or agent forfeit the value of such stock, and shall not collect the same from the purchaser or consignee.

62. That the State Entomologist, State Pathologist and State Horticulturalist shall submit annually a written report on or before the first day of February, of their inspections and investigations, to the Board of Trustees, which shall be transmitted to the Governor of this State and the General Assembly, and published, as are the reports of other State organizations, and distributed among the people of the State as bulletins of the Maryland Agricultural Experiment Station.

63. That the report of the present State Entomologist, including the work done by him up to the date of the passage of this Act, shall be published and distributed as indicated and provided for in Section 62 of this Act, as the first annual report of the Maryland State Entomologist.

64. That the sum of ten thousand dollars the first year, and eight thousand dollars annually thereafter, be and is hereafter appropriated in order to carry out the provisions of this Act and properly provide for the above described inspections; to employ men qualified for their respective positions; to procure the requisite facilities and equipment necessary for the proper performance of the duties herein incurred, and to offer means of support for investigation in addition to the inspection work of the State officers, and the dissemination of information that will promote the horticultural and agricultural interests of this State.

65. That the Comptroller be and that he is hereby authorized to issue his warrant upon the Treasurer of this State for the said sum of ten thousand dollars for the year eighteen hundred and ninety-eight, and the sum of eight thousand dollars annually thereafter, out of any funds not otherwise appropriated; that the said sum of money shall be payable to the Maryland Agricultural College on or before the first of October of each fiscal year, and the first yearly payment shall be made during the fiscal year ending September 1st, eighteen hundred and ninety-eight.

Section 3. AND BE IT ENACTED, That this Act shall take effect from the date of its passage.

Approved April 9th, 1898.

This is the first bulletin published according to the provisions embodied in Section 64 of this Act, giving general information to the public on topics of economic importance. Others will follow as occasion demands.

MARYLAND

Agricultural Experiment Station.

BULLETIN NO. 56.

Wheat, Winter Oats, Barley and Lime Experiments.

COLLEGE PARK, MD.

JUNE, 1898.

MARYLAND
Agricultural Experiment Station.

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NOTICE.

The bulletins of the Station will be mailed free to any citizen of Maryland who sends his name and address to the Station for that purpose.

Correspondents will please notify the Director of changes in their post-office address, or any failure to receive the bulletins.

ADDRESS,

MARYLAND AGRICULTURAL EXPERIMENT STATION,
COLLEGE PARK, MD.

Wheat, Winter Oats, Barley and Lime Experiments.

For the Years 1896 and 1897.

SUMMARY OF RESULTS.

1.—In the variety tests with Wheat for a period of six years, Fultz leads, with an average yield of 37.8 bushels, followed by Currell's Prolific, yielding 36.2, Wisconsin Triumph 34.9 bushels, and Valley 33.7 bushels.

2.—Promising varieties of later introduction are Beal, Rocky Mountain, Ruby and Terry.

3.—With two crops, corn and wheat, the increased yields produced by different amounts of lime, placed the limit of profit with an application of 40 bushels per acre.

4.—Lime in connection with peas, increased the yield of wheat slightly, and produced a marked improvement in the set of grass.

5.—Twenty bushels of stone lime per acre applied for corn in 1893, produced an increase of 110 per cent. in the hay crop of 1896, and a second application of lime (25 bus. Oyster Shell Lime) for corn produced an increase of 66 per cent. of grain in 1897.

6.—The best variety of winter oats tested was Virginia Gray, yielding 48.8 bushels per acre.

7.—The most favorable time for seeding winter oats in this latitude, seemed to be about Sept. 1st.

8.—The hot water treatment of Barley seed was effective in preventing smut; increasing the yield 16 per cent.

Wheat, Winter Oats, Barley and Lime Experiments.

By Robert H. Miller and E. H. Brinkley.

The following experiments were made with wheat, oats and barley during the seasons of 1896 and 1897:

No. 1. Testing varieties of wheat 1896 and 1897.
No. 2. Testing effect of different amounts of lime on wheat 1897.
No. 3. Testing effect of lime and cow peas as a preparation for wheat.
No. 4. Testing the effect of lime on hay and corn.
No. 5. Testing varieties of winter oats 1897.
No. 6. Test as to time of seeding winter oats 1896 and 1897.
No. 7. Testing the effect of hot water treatment for smut on barley 1896.

VARIETY TESTS OF WHEAT—1896.

The land used for this test was in corn in 1894, crimson clover having been seeded at the last working of the corn, which was plowed down the following June as a preparation for the crop of wheat. The ground was gotten in thorough order, and on September 24th fertilizer, at the rate of 300 pounds to the acre, was applied with the drill. This fertilizer was composed as follows:

Dissolved South Carolina rock	667 lbs.
Dried fish	833 "
Muriate of potash	500 "
Total	2000 "

September 27th and 28th, the wheat was seeded, one and one-half bushels to the acre, and 200 pounds additional fertilizer was applied to the acre, composed of:

Dissolved South Carolina rock	1500 lbs.
Nitrate of soda	500 "
Total	2000 "

The plots contained 3622.5 square feet, and every fifth plot was seeded to Currell's Prolific Wheat, as a check plot. The wheat was cut June 15th, and threshed from the field July 2d and 3rd.

TABLE I.

Yields per Acre and Characteristics of Varieties of Wheat Tested in 1896. Size of Plots 230 feet by 15 3-4 feet, or 3622.5 square feet.

Plot No.	VARIETY.	YIELD PER ACRE OF GRAIN.	COLOR OF GRAIN.	BEARDED OR SMOOTH.	NATURE OF STRAW.	TIME OF RIPENING.
1	Extra Early Oakley.	31.5	Amber.	Smooth.	Stiff.	Early.
2	Valley............	34.8	Red.	Bearded.	Stiff.	Medium.
3	Pool...............	35.1	Red.	Smooth.	Stiff.	Early.
4	Fultz.............	36 0	Red.	Smooth.	Stiff.	Early.
5	**Currell's Prolific....**	34.3	Red.	Smooth.	Fairly Stiff.	Early.
6	Badger.............	33.0	Red.	Smooth.	Stiff.	Early.
7	Ontario Wonder....	30.8	Red.	Smooth.	Stiff.	Late.
8	Rocky Mountain....	32.9	Red.	Smooth.	Stiff.	Early.
9	Wyandott Red......	34.7	Red.	Smooth.	Stiff.	Medium.
10	**Currell's Prolific....**	34.1	Red.	Smooth.	Fairly Stiff.	Early.
11	Finley.............	35.1	Red.	Smooth.	Fairly Stiff	Medium.
12	Wisconsin Triumph.	35.2	Amber.	Smooth.	Stiff.	Early.
13	Garfield...........	34.9	Red.	Smooth.	Fairly Stiff.	Medium.
14	Terry..........	37 4	Red.	Smooth.	Stiff.	Early.
15	**Currell's Prolific....**	35.9	Red.	Smooth.	Fairly Stiff	Early.
16	Russel.............	38.9	Red	Smooth.	Stiff.	Early.
17	Jones' Square Head	29.6	White.	Smooth.	Stiff.	Late.
18	Ruby...............	36.0	Red.	Bearded.	Stiff.	Late.
19	Deitz..............	32.3	Red.	Bearded.	Fairly Stiff	Early.
20	**Currell's Prolific ...**	34.2	Red.	Smooth.	Fairly Stiff.	Early.
21	Lehigh.............	33 9	Red.	Bearded.	Fairly Stiff.	Medium.
22	Lebanon............	32.5	Red.	Bearded.	Weak.	Medium.
23	Tuscan Island......	33.8	Red.	Bearded.	Stiff.	Medium.
24	Beal...............	33.1	Amber.	Bearded.	Stiff.	Medium.
25	**Currell's Prolific...**	27.7	Red.	Smooth.	Fairly Stiff.	Early.
26	Nigger.............	37.0	Red.	Bearded.	Stiff.	Early.
27	Egyptian..........	32.1	Red.	Bearded.	Fairly Stiff	Early.

VARIETY TESTS OF WHEAT—1897.

The preparation of land for variety tests of wheat for 1897 was similar to that described in the previous tests, crimson clover having been plowed down. The wheat was seeded September 28th and 29th, one and one-half bushels of seed per acre and 400 pounds of fertilizer applied at the time of seeding. The fertilizer was composed as follows:

Dissolved South Carolina Rock...............	1000	lbs.
Tankage..............................	500	"
Muriate of potash......................	300	"
Nitrate of soda........................	200	"
Total..........................	2000	"

23 varieties were seeded, and the plots were 21 by 200 feet, containing 4200 square feet, or about 1-10 of an acre. Every fifth plot was seeded to Fultz as a check variety. The wheat was cut June 28th and 29th, and threshed from the field. Table II gives yields, etc.

TABLE II.

Yields per Acre and Characteristics of Varieties of Wheat Tested in 1897.
Size of Plot 21 by 200 feet, or 4200 square feet.

Plot No.	VARIETY.	YIELD PER ACRE OF GRAIN	COLOR OF GRAIN.	BEARDED OR SMOOTH.	NATURE OF STRAW.	TIME OF RIPENING.
1	Extra Early Oakly..	31.5	Amber.	Smooth.	Stiff.	Early.
2	Pool	31.2	Red.	Smooth.	Stiff.	Early.
3	Currell's Prolific....	39.9	Red.	Smooth.	Fairly Stiff.	Early.
4	Badger..............	31.5	Red.	Smooth.	Stiff.	Early.
5	**Fultz**.	46.5	Red.	Smooth.	Stiff.	Early.
6	Ontario Wonder.....	31.1	Red.	Smooth.	Stiff.	Late.
7	Rocky Mountain....	41.8	Red.	Smooth.	Stiff.	Early.
8	Wyandott Red......	41.0	Red.	Smooth.	Stiff.	Medium.
9	Finley.	39.0	Red.	Smooth.	Fairly Stiff.	Medium.
10	**Fultz**.........	41 3	Red.	Smooth.	Stiff.	Early.
11	Wisconsin Triumph.	40.6	Amber.	Smooth.	Stiff.	Early.
12	Garfield.......	39.1	Red.	Smooth.	Fairly Stiff.	Medium.
13	Terry.................	37.7	Red.	Smooth.	Stiff.	Early.
14	Russel	31.8	Red.	Smooth.	Stiff.	Medium.
15	**Fultz**	46.7	Red.	Smooth.	Stiff.	Early.
16	Jones' Square Head.	36.1	White	Smooth.	Stiff.	Late.
17	Valley	36.8	Red.	Bearded.	Stiff.	Medium.
18	Ruby................	39.6	Red.	Bearded.	Stiff.	Late.
19	Deitz................	39 5	Red.	Bearded.	Fairly Stiff	Early.
20	**Fultz**................	40.6	Red.	Smooth.	Stiff.	Early.
21	Lehigh	34.7	Red.	Bearded.	Fairly Stiff.	Medium.
22	Lebanon	42.2	Red.	Bearded.	Down.	Medium.
23	Tuscan Island.	38.2	Red.	Bearded.	Stiff.	Medium.
24	Beal	49.6	Amber.	Bearded.	Stiff.	Medium.
25	**Fultz**................	43.9	Red.	Smooth.	Stiff.	Early.
26	Nigger..............	32.7	Red.	Bearded.	Stiff.	Early.
27	Egyptian......	35.3	Red.	Bearded.	Fairly Stiff	Early.

In table 3 will be found the yields of varieties of wheat tested at the Station the past season, together with the yields for other years of the varieties in this list, which have been previously tested, and the average yields of those varieties for the years grown.

TABLE III.

Average Yields of Wheat for the Years Grown.

VARIETY.	1897	1896	1895	1894	1893	1891	1890	NUMBER OF YEARS GROWN.	AVERAGE
Garfield................	39.1	34.9	24.2	44.2	42.5	10.3	....	6	32.8
Valley....................	36.8	34.8	39.1	42.9	41.7	..	6.7	6	33.7
Beal.......................	49 6	33.1	31.7	42.3	26.8	....	....	5	36.7
Fultz.......................	43.8	36.0	36.6	41.7	47.1	21.4	....	6	37.8
Currell's Prolific........	39.9	33.2	42.3	45.5	36.8	19.7	13.6	7	33.0
Terry....................	37.7	37.4	....	....	....	....	....	2	37.5
Wisconsin Triumph.....	40.6	35.2	35 6	35.4	47.9	14.5	....	6	34.9
Finley....................	39.0	35.1	36.2	40.2	33 6	20.2	12.7	7	31.0
Nigger....................	32.7	37.0	33.8	39.0	24.0	7.5	6.5	7	25.8
Egypt.....................	35.3	32.1	29.6	39.2	28.0	16.3	15.4	7	30 0
Jones' Square Head.....	36.1	29.6	27.8	40.0	32.8	....	...	5	33.2
Tuscan Island...........	38.2	33.8	38.1	38.7	42.4	7.8	16.6	7	30.8
Poole.....................	31.2	35.1	39.1	36.5	....	12.5	9.9	6	27.4
Rocky Mountain.........	41.8	32.9	38.1	33.3	....	....	...	4	36.5
Wyandott Red..........	41.0	34.7	38.8	35.7	27.6	19.6	12.7	7	30.0
Badger..................	31.5	33.0	38.2	37.1	46 1	....	9.3	6	32.5
Dietz.....................	39.5	32.3	37.1	38.9	42.0	10.5	21.2	7	31.6
Extra Early Oakley.....	31.5	31.5	42.4	38.7	29.6	17.9	....	6	31.9
Lebanon.................	42.2	32 5	33.4	39.3	30.2	....	....	5	35.5
Ontario Wonder.........	31.1	30 8	39 7	36.1	31.3	8.5	4.6	7	26.0
Lehigh....................	34.7	33.9	37.0	35.2	31.4	....	....	5	34.4
Ruby......................	39.6	36.0	41.0	....	....	....	....	3	38.8
Russell.................	31.8	38.9	....	....	....	....	....	2	35.3

As will be seen in Table III, the Fultz has given the highest average yield of any of the varieties tested, showing no sign of deterioration, after more than a quarter of a century has passed since its introduction. Its average yield for the six years it has been tested being 37.8 bushels. In exceptional cases, where farmers have gotten poor yields of Fultz, the cause has probably been from having used mixed or deteriorated seed, rather than from any fault of the variety.

Currell's Prolific comes next, with an average yield of 33.0 bushels for the seven years which it has been tested. The average yield of this variety for the six years which the Fultz has been tested is 36.2 bushels. Wisconsin Triumph comes third, with an average of 34.0 bushels for six years. Valley fourth, with an average of 33.7 bushels. Of the promising new varieties may be mentioned Beal, Ruby, Terry and Rocky Mountain.

TESTING THE EFFECT OF DIFFERENT AMOUNTS OF LIME ON WHEAT—1897.

This experiment is a continuation of the one reported in Bulletin No. 46, page 62, of this Station. As stated in this bulletin, "the object of the experiment is to ascertain the most profitable amount of lime to apply per acre on land, for a series of crops, first corn, followed by wheat, grass, etc.

The land as stated in the report referred to, was very poor, the producing capacity, without the help of lime, being about 17 bushels of corn to the acre.

Eight plots are used in the test, two of them, plots 3 and 6, having had no lime applied; the other six having applications of 10, 20, 30, 40, 50 and 60 bushels to the acre, respectively. These plots were planted to corn the spring of 1896, the yields, etc., of which are reported in Bulletin No. 46. After the corn and fodder had been removed from them the succeeding fall, and the land thoroughly prepared with a "cut-away" harrow, they were seeded to wheat and timothy, one and one-half bushels of wheat, and six quarts of timothy to the acre, and 600 pounds of fertilizer applied, of the same composition as that used on varieties of wheat. The following spring six quarts of early clover seed to the acre was sown. In Table IV will be found the yields of the respective plots.

TABLE IV.

Lime Test with Wheat, 1897.—Size of Plots 160 feet by 30 feet, or 4800 Square Feet.

Plot No.	Quantity Lime Per Acre.	Yield of Grain Per Acre.	Cost of Lime Per Acre. At 18c.* bushel.
	Bush.	Bush.	
1	10	26.0	$1.80
2	20	27.7	3.60
3	No lime.	22.5	......
4	30	28.7	5.40
5	40	31.9	7.20
6	No lime.	22.7	......
7	50	31.0	9.00
8	60	32.5	10.80

*This is based on 14 cents bushel for first cost of lime and 4 cents for hauling and spreading
(Stone lime weighing 80 pounds to the bushel).

It will be seen from Table IV that there was a very marked effect from the use of lime on the plots receiving it, and it will be further noticed that the yields of wheat on plots 1, 2, 4 and 5, those receiving 10, 20, 30 and 40 bushels of lime to the acre, respectively, were in direct proportion to the amount of lime applied, but it will be noticed that this relation did not obtain on the plots receiving more than 40 bushels of lime, as plot 7, which received 50 bushels to the acre, yielded less wheat than plot 5, and plot 8, receiving 60 bushels to the acre, yielded only slightly more than plot 5.

The effect of the lime in setting the clover and timothy, is very marked, there being no apparent difference in the stand on any of the plots receiving the lime, while on the check plots 3 and 6, which received no lime, there is a very poor stand of both clover and timothy.

Table V shows the relative profits gained with the crops, corn and wheat, as a result of the application of the different amounts of lime.

TABLE V.

Comparative Profits from Different Amounts of Lime on Corn and Wheat

Plot No.	Bushels of Lime per Acre	Bushels of Corn per Acre 1896.	Bushels of Wheat per Acre 1897.	Value of Gain in Corn 30 cents per bus. 1896.	Value of Gain in Wheat at 90 cts per bus 1897.	Value of Gain in Wheat and Corn, 1896 and 1897.	Cost of Lime per Acre at 18 cents per bus.	Relative Profit per Acre for two Crops.
1	10	23.9	26 0	$2.28	$3.06	$5.34	$1.80	$3.54
2	20	25 6	27.7	2.79	4.59	7.38	3.60	3.78
3	No lime.	17.4	22.5	....	..		....	....
4	30	25.8	28.7	2.85	5.49	8 34	5.40	2 94
5	40	27.1	31.9	3 24	8 37	11.61	7.20	4.41
6	No lime.	15.3	22.7		...		....	....
7	50	28.8	31 0	3 75	7.56	11.31	9.00	2.31
8	60	29.8	32.5	4.05	8.91	12 96	10 80	2.16

As will be seen, plot 5, receiving 40 bushels of lime to the acre, gave a slightly larger net return than any of the others, though amounting to but eighty-five cents to the acre more than was received from plot 1, which received only 10 bushels of lime to the acre.

TESTING THE EFFECT OF LIME AND COW PEAS AS A PREPARATION FOR WHEAT.

This experiment was undertaken the spring of 1896. The two plots used in the test immediately adjoined those used in the test of different amounts of lime on wheat. The object of the experiment was to ascertain the effect of lime in the improvement of worn-out soils, when used in conjunction with green manures, such as cow peas. As stated, the land was very poor, its natural capacity being about 17 bushels of corn to the acre. The plots were plowed and prepared for seeding on May 12th, when 40 bushels of stone lime was applied to plot 10, plot 9 receiving none. On the 13th, cow peas, at the rate of five pecks to the acre, were drilled in on each plot without any fertilizer. There was quite an apparent difference in the growth of peas on the two plots, both in the color and density of the growth, being in favor of the plot receiving the lime. On August 24th, the peas on both plots were plowed down. October 2d they were seeded to wheat, one and one-half bushels to the acre, and six quarts of timothy seed sown. 400 pounds of fertilizer of the same composition as that used on varieties of wheat was applied Clover seed was sown on both plots the following spring.

Table VI gives the yields of the two plots. As will be seen, there was a gain of only 1.6 bushels of wheat to the acre from the application of lime, but there is a very marked difference in the set of grass. The plot which received the lime having a very fine stand of both clover and timothy, while there is scarcely any clover and a poor stand of timothy on the plot receiving no lime.

TABLE VI.

Cow Peas with Lime vs. Cow Peas without Lime, as a Preparation for Wheat.

PLOT.		BUSHELS.
9	Cow Peas no Lime	32.4
10	Cow Peas 40 bushels Lime	34.0
Gain in Favor of Lime		1.6

TESTING THE EFFECT OF LIME ON HAY AND CORN.

This experiment was a continuation of the one undertaken the spring of 1893. The object of the experiment was to note the effect of lime on a series of crops, commencing with corn, followed by wheat and two crops of hay, and this rotation to be repeated again with another application of lime previous to planting in corn. Two plots were used in the test. On one of them stone lime was applied at the rate of 20 bushels to the acre, the other plot receiving none. The lime was applied after being slacked, and just before planting the corn. The increase from the lime in the crop of corn was 5½ bushels to the acre, or a gain of 34.7 percent. In the following crop of wheat, the increase on the limed plot was 8.5 bushels to the acre, or a gain of 37.3 per cent. In the following crop of hay, which was the third crop after liming, the increase from lime was 1271 lbs. to the acre, or a gain of 91.3 per cent.

The second crop of hay was cut the season of 1896, the yields of which are given in Table VII. It should be stated that what little clover and timothy there had been on the unlimed plot when the first crop of hay was cut, had nearly all disappeared, and there was little left but weeds, while on the limed plot there was still a fair stand of timothy and some clover. A comparison of yields of the two plots, therefore, is practically of weeds with hay.

TABLE VII.

Yield of Hay as a Result of Lime vs. no Lime.

PLOT.		YIELD OF HAY PER ACRE.
1	Limed	758 lbs.
2	Unlimed	361 "
	Gain from Lime	397 "

As will be seen from Table VII, the plot which was limed yielded more than double the product of that which was not limed, the gain being 110.3 per cent., but at best the yield of hay on the limed plot was poor, and showed a marked falling off from the previous year, when the yield was at the rate of 2662 lbs. to the acre. This falling off in yield was partly due to the season, which was not a favorable one for the hay crop, but more particularly due to the fact that the land was deficient in fertility, having been practically bare of vegetable matter when the experiment was begun, and having produced in the meantime a crop of corn, a crop of wheat and a crop of hay, with one application of fertilizer for the wheat. With the ultimate object of improving the land, it would have been much better to have plowed the one year old sod when the clover was at its best, thereby increasing the amount of humus in the soil, rather than depleting it by cutting the second crop of hay.

CORN.—The winter of 1897 the two plots were plowed, and the following spring 25 bushels of oyster shell lime was applied on the one which had previously been limed, the other plot receiving none, when the plots were planted to corn the second time.

Table VIII gives the yields of corn and fodder. As will be seen, the increase for corn on the limed plot was 17.7 bushels per acre, or a gain of 66.6 per cent. At the last working of the corn crimson clover was sown on both plots, and this will be plowed down as a preparation for wheat, which will be seeded the fall of 1898.

TABLE VIII.

Yield of Corn and Fodder as a result of Lime vs. no Lime.—Size of Plots 11,395 square feet.

PLOT.		PER ACRE HARD.		PER ACRE SOFT.		PER ACRE TOTAL.		PER ACRE FODDER.
		Bus.	Lbs.	Bus.	Lbs.	Bus.	Lbs.	Lbs.
1	Limed	37	0	6	42	43	42	2615
2	Unlimed	16	28	9	56	26	2	1475
	Gain from Lime					17	40	1140

Gain for fodder of the limed over the unlimed plot......39.8 per cent.
Gain for corn of the limed over the unlimed plot......66.6 per cent.

For the purpose of bringing in closer comparison the yields of the two plots through the series of crops, we give the following table, which contains the yields of the several crops for the years grown, and the per cent. of gain from lime on each crop:

TABLE IX.

Yield of Limed and Unlimed Plots for Five Years.

Crop and Year.	Plot 1, Limed.		Plot 2, Unlimed.		Gain as a Result of Liming.			
					Grain.		Hay or Fodder.	
	Grain	Hay or Fodder.	Grain	Hay or Fodder	Bus.	Per Cent.	Lbs.	Per Cent.
	Bus.	Lbs.	Bus.	Lbs.				
Corn—1893	21.4	2200	15.8	1792	5⅓	34.7	408	18.1
Wheat—1894	31.3	....	22.8	....	8½	37.3	......	....
Hay—1895	.....	2662	......	1391	......	.....	1271	91.3
Hay—1896	.....	756	.....	360	......	......	396	110.3
Corn—1897	43.6	2015	26.03	1475	17.6	66.4	540	39.8

As will be seen from Table IX, the effect of lime on each of the five crops thus far harvested has been very marked. Commencing with corn, the gain in grain was 34.7 per cent., and the increase in the yield of fodder was 18.1 per cent. The gain for lime in the following crop of wheat was 37.3 per cent. The third crop in order, hay, showed for lime an increase of 91.3 per cent. In the second crop of hay, or the fourth crop harvested, the increase was 110.3 per cent. in favor of lime, and the last crop, corn, gave 66.4 per cent. increase of grain and 39.8 per cent. increase of fodder in favor of lime.

VARIETY TESTS OF WINTER OATS—1897.

Three varieties of winter oats were seeded the fall of 1896 on land which had been in strawberries the previous spring. The land had been plowed in July, soon after the strawberries were out of the way, and laid fallow until September 3rd, when the oats were seeded, two bushels to the acre, and 300 pounds of fertilizer applied.

In Table X will be found the yields of the varieties tested:

TABLE X.

Yield of Varieties of Winter Oats, 1897.—Size of Plots 287 ft. by 45 ft. or 9315 square feet.

Plot No.	Name.	Bushels per Acre.
4	Hatchett Black Winter	37.4
5	Winter	47.6
6	Virginia Gray	48.8

TEST AS TO TIME OF SEEDING WINTER OATS—1896 and 1897.

Bulletin No. 35 reports a test of winter oats seeded the fall of 1894. This was sown September 24th, or about the time of seeding wheat. It made a comparatively light growth in the fall, and much of it was thrown out the succeeding winter. It was harvested June 28th, and the yield was only 31.6 bushels to the acre. With the object of ascertaining if earlier seeding would not give better results, three seedings were made the fall of 1895 and also 1896. The dates of these seedings were September 1st, 15th and 30th. Two bushels of seed to the acre, of the variety known as the "Virginia Gray," was sown, and a light application of about 250 pounds of fertilizer applied. The size of plots in 1896 was 15 3-4 by 264 feet, in 1897 21 feet by 60 feet.

In Table XI will be found the yields of the different dates of seeding for the two years in which the tests were made. As will be seen the early seeding gave a decidedly better yield for both years which the test was made.,

TABLE XI.

Yield per Acre of Winter Oats Seeded at different Periods 1896 and 1897.

Plot No.	VARIETY USED.	TIME OF SEEDING.	BUSH. 1896	BUSH. 1897	AVERAGE BUSH.
1	Virginia Gray........	September 1st.	63.7	60.4	62.0
2	Virginia Gray........	September 15th.	38.2	53.0	45 6
3	Virginia Gray........	September 30th.	54.1	51.0	52.5

TEST OF HOT WATER TREATMENT OF SEED BARLEY FOR PREVENTION OF SMUT.

The Indiana Experiment Station recommends the following treatment for small grains, such as wheat, oats or barley, for the prevention of smut:

"Immerse the seed grain for five minutes in water standing at first at 135 to 145 F., which may drop during the operation to 130, or may even fall below 130, if the time is correspondingly prolonged.

"After drying, by spreading upon a floor, the seed may be sown immediately or after a time, with equally beneficial results in either case."

As the two crops of barley grown here had been badly affected with smut, it was deemed advisable to test the effect of this treatment for its prevention. Two plots of barley were seeded the fall of 1895; on one of them the seed was treated as above, the other was not treated. The effect of the treatment was very marked, the plot on which the seed had been treated having practically no smut, while on that which was untreated there were from 15 to 20 per cent. of the heads smutted.

Table XII gives the yields of the treated and untreated plots:

TABLE XII.

Results of the effect of Hot Water Treatment for Smut on Barley, 1896.
Size of Plot 264 feet by 15 3-4 feet, or 4158 square feet.

Plot No.		YIELD PER ACRE.
		Bus.
1	Not Treated	34.4
2	Treated	40.0
Gain as a result of treatment		5.6

As will be seen from Table XII. the plot on which the seed was treated yielded 5.6 bushels more to the acre than the plot which had untreated seed, or a gain of 16 per cent.

PUBLICATIONS OF THE MARYLAND EXPERIMENT STATION.

	Bulletin	No.	1,	June,	1888,	History, Organization and Work of the Station.
*	"	"	2,	Sept.,	1888,	Cutting Seed Potatoes for Planting. Appendix, with Information About Station.
*	"	"	3,	Dec.,	1888,	Fodder-Corn and Fodder-Cane. Appendix, About Taking and Sending Samples.
*	"	"	4,	March,	1889,	Experiment Orchard.
	"	"	5,	June,	1889,	Horticultural Department and Field Experiments.
	"	"	6,	Sept.,	1889,	Commercial Fertilizers.
	"	"	7,	Dec.,	1889,	Farm Manures.
*	"	"	8,	March,	1890,	Some Feeding Trials.
*	"	"	9,	June,	1890,	Strawberries.
*	"	"	10,	Sept.,	1890,	Wheat.
*	"	"	11,	Dec.,	1890,	Tomatoes.
	"	"	12,	March,	1891,	Pig Feeding.
*	"	"	13,	June,	1891,	Strawberries.
*	"	"	14,	Sept.,	1891,	Wheat
*	"	"	15,	Dec.,	1891,	Experiment Vineyard.
*	"	"	16.	March,	1892,	Wheat Insects.
*	"	"	17.	June,	1892,	Strawberries and Seed Potatoes.
*	"	"	18,	Oct.,	1892,	Sweet Potatoes.
*	"	"	19,	Dec.,	1892,	Tomatoes.
*	"	"	20,	March,	1893,	The Composition and Digestibility of the Different Parts of Corn Fodder.
*	"	"	21.	June,	1893,	The soils of Maryland.
	"	"	22,	Sept.,	1893,	Steer Feeding: a Well Balanced vs. a Poorly Balanced Ration
*	"	"	23,	Dec.,	1893,	Injurious Insects of Maryland.
	"	"	24,	Feb.,	1894,	Composition of Commercial Fertilizers Sold in This State.
*	"	"	25,	March,	1894,	Agricultural and Horticultural Departments. Corn, Potatoes, Tomatoes, Strawberries, Grapes, &c.
	"	"	26,	June,	1894,	Tobacco.
	"	"	27,	Aug.,	1894,	Composition of Commercial Fertilizers Sold in This State.
	"	"	28,	Sept.,	1894,	Experiments with Wheat and Barley.
	"	"	29,	Dec.,	1894,	Further Investigations on the Soils of Maryland.
*	"	"	30,	Jan.,	1895,	Composition of Commercial Fertilizers Sold in This State.
	"	"	31,	March,	1895,	Potato Experiments.
	"	"	32,	April,	1895,	The San Jose Scale.
	"	"	33,	April,	1895,	Horticultural and Agricultural Departments. Small Fruits, Vegetables and Field Corn.
	"	"	34,	July,	1895,	Composition of Commercial Fertilizers Sold in This State.
	"	"	35,	Sept.,	1895,	Wheat, Barley, Oats and Hay Experiments.
	"	"	36,	Dec.,	1895,	Steer Feeding: a Well Balanced vs. a Poorly Balanced Ration.
	"	"	37,	Feb.,	1896,	Composition of Commercial Fertilizers Sold in This State.
	"	"	38,	March,	1896,	Potato Experiments.
	"	"	39,	April,	1896,	Spray Calendar.
	"	"	40,	Aug.,	1896,	Composition of Commercial Fertilizers Sold in This State.
	"	"	41,	Sept.,	1896,	Test of Methods of Preparing and Feeding Corn Fodder.
	"	"	42,	Oct.,	1896,	The Md. Trees and Nursery Stock Law and Other Information of Special Interest to Nurserymen and Fruit Growers.

	Bulletin	No. 43,	Dec.,	1896,	Report upon the Value of a New Corn Product.
*	“	“ 44,	Dec.	1896,	The Soils of the Hagerstown Valley.
*	“	“ 45,	Feb.	1897,	Commercial Fertilizers Sold in This State.
	“	“ 46,	March.	1897,	Corn and Potato Experiments.
	“	“ 47,	June,	1897,	Dairy Farming.
	“	“ 48,	June,	1897,	Some Common Injurious Plant Lice with Suggestions for their destruction.
	“	“ 49,	Aug.,	1897,	Composition of Commercial Fertilizers Sold in This State.
	“	“ 50,	Sept.,	1897,	Rust and Leopard Spot, two Dangerous Diseases of Asparagus.
	“	“ 51,	Dec ,	1897,	Horse Feeding. Tests of the Digestibility of Oats, Corn, Hay and the New Corn Product.
	“	“ 52,	Feb.	1898,	Composition of Commercial Fertilizers Sold in This State.
	“	“ 53,	March,	1898,	Special Investigation of the So-called “New” Horse Disease in Maryland.
	“	“ 54,	March,	1898,	Tomatoes.
	“	“ 55,	May,	1898,	The Black Peach Aphis—Cut Worms in Young Tobacco—Law Providing for the Suppression and Control of Insect Pests and Plant Diseases in Maryland.

*	Special	Bulletin	(A),	Fair Edition,	1889,	Facts About the Station.
*	“	“	(B),	July,	1890,	Potash and Paying Crops.
	“	“	(C),	Oct.,	1890,	Composition of Commercial Fertilizers Sold in This State.
*	“	“	(D),	Feb.,	1891,	Composition of Commercial Fertilizers Sold in This State.
*	“	“	(E),	Aug.,	1891,	Composition of Commercial Fertilizers Sold in This State.
*	“	“	(F),	Jan.,	1892,	The Agricultural Outlook for Maryland.
	“	“	(G),	Feb.,	1892,	Composition of Commercial Fertilizers Sold in This State.
	“	“	(H),	July,	1892,	Government Direction of Agriculture in Europe.
*	“	“	(I),	Aug.,	1892,	Composition of Commercial Fertilizers Sold in This State.
*	“	“	(J),	Feb.,	1893,	Composition of Commercial Fertilizers Sold in This State.
*	“	“	(K),	June,	1893,	Composition of Commercial Fertilizers Sold in This State.

	First	Annual	Report	of	the	Maryland	Agricultural	Experiment	Station, 1888.
	Second	“	“	“	“	“	“	“	“ 1889.
	Third	“	“	“	“	“	“	“	“ 1890.
*	Fourth	“	“	“	“	“	“	“	“ 1891.
	Fifth	“	“	“	“	“	“	“	“ 1892.
	Sixth	“	“	“	“	“	“	“	“ 1893.
	Seventh	“	“	“	“	“	“	“	“ 1894.
	Eighth	“	“	“	“	“	“	“	“ 1895.
	Ninth	“	“	“	“	“	“	“	“ 1896.
	Tenth	“	“	“	“	“	“	“	“ 1897.

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*Edition Exhausted—no more for distribution.

Report
ON THE
San Jose Scale in Maryland
AND
Remedies for its Suppression and Control.

BULLETIN No. 57
OF THE
MARYLAND AGRICULTURAL
EXPERIMENT STATION,

COLLEGE PARK, MD.
AUGUST, 1898.

THE

Maryland Agricultural Experiment Station.

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The Station is located on the B. & O. R. R. 8 miles north of Washington, D. C.

Visitors will be welcomed at all times, and will be given every opportunity to inspect the work of the Station in all its departments.

The Bulletins and reports of the Station will be mailed regularly, free of charge, to all residents of the State who request it.

ADDRESS

AGRICULTURAL EXPERIMENT STATION,

College Park, Maryland.

PROF. C. V. RILEY.

THE MARYLAND
AGRICULTURAL EXPERIMENT STATION

BULLETIN No. 57. AUGUST, 1898.

Report on the San Jose Scale in Maryland, and Remedies for its Suppression and Control.

By Willis G. Johnson, A. M., Entomologist.

INTRODUCTORY.

It was the intention of the writer to have embodied this report in a more exhaustive one, including all the work of this department for the years 1896 and 1897, but the lack of funds precluded its publication. This report, therefore, in its present form, is published exclusively out of the funds of the State Horticultural Department, and embraces my observations and experimental operations as State Entomologist and Entomologist of the Agricultural Experiment Station.

I wish to acknowledge here my grateful appreciation of the encouragement and hearty cooperation I have always received from President R. W. Silvester, of the Agricultural College, in the development of my department and the prosecution of my work. I am also under many obligations to Mr. Franklin Sherman, Jr., who voluntarily assisted me from July, 1896, to April, 1897. My thanks are also due to Mr. Robt. H. Miller, former director of the station, and especially, to Mr. Robert S. Emory, who has so materially assisted me in my experimental work. I have also been shown many favors by Dr. L. O. Howard, the United States Entomologist, for which I am very grateful. Mr. E. Dwight Sanderson, my assistant, has also rendered much valuable service. I am also indebted to the fruit growers and nurserymen who have ever been ready to assist me and cooperate with me along any line of experimental work. I desire also to thank Mrs. C. V. Riley for the excellent photograph of her late husband, which is herewith reproduced.

The author regrets exceedingly that he cannot give, at this time, all the experimental work that has been completed, and is now ready for publication. The results, however, will be given to the general public as rapidly as possible, in this series of bulletins, of which this is the second, published in accordance with the Laws of Maryland 1898, Chapter 289.

PROF. C. V. RILEY.

It is a pleasure for me to preface my report with a short sketch of my predecessor as station entomologist, the late Professor C. V. Riley. The frontispiece shows him in his characteristic position at work, and is reproduced for the first time from one of his latest photographs, taken in 1893, about the time he became officially connected with the Maryland Agricultural Experiment Station.

In June, 1893, Prof. Riley was elected Entomologist and Physiologist of the Station a position he occupied up to the time of his death. During his connection with the station he attended to the correspondence of his department and published two bulletins. The first, (Bul. No. 23) appeared in December, 1893, and was a popular account of some injurious species, the first of a series which he intended to have issued upon the insects of Maryland. The second, (Bul. No. 32) was issued in April, 1895, and embodied an account of the San Jose scale in this state. It was his intention to have added to the station cabinet a set of the insects he had in duplicate in his collections. This collection had been started, and eight cases of beetles and two of butterflies had been transferred to the station before his death occurred.

As an officer of the station, and for the entomology of Maryland, Professer Riley had planned to prosecute some original research and investigate many unsolved problems of economic importance; but all was cut short by his untimely end.

The circumstances which occasioned the death of Professor Riley are very sad. September 14th, 1895, shortly after nine o'clock, he mounted his bicycle, and in company with his son, started from his residence on Wyoming Avenue in Washington, D. C., for the central part of the city. Before reaching Connecticut Avenue, a short distance away, he was accustomed to going down a rather steep hill, and on this occasion those who saw him noticed that he was riding more rapidly than usual. At the intersection of Connecticut avenue and S street the front wheel of his bicycle struck a piece of granite lying on the concrete, and, turning suddenly at right angles, Professor Riley was thrown with great force, head downward on the pavement. His apparently lifeless body was picked up and laid on the parking, and in a few minutes several physicians were present. Everything possible was done for the unfortunate man, but to no avail. He died shortly after midnight September 15.

The following biographical sketch is too brief for us to do homage to the man who, pre-eminent above all others, has done so much to place economic entomology upon a footing with other allied sciences; but space will not permit me to say more in this place.

Charles Valentine Riley was born in London, September 18, 1843. He spent his early boyhood days in the village of Walton, on the Thames, and at an early age exhibited a fondness for collecting, and took a keen interest in painting and drawing. When ten years of age he began collecting notes and making drawings of the insects in his neighborhood, with a view, as he said, of describing the transformations of all the species in that vicinity. Dr. L. O. Howard, the present United States

Entomologist, who has seen these early drawings, says they "indicate a most unusual artistic talent."

By the death of his father, who was a clergyman of the Church of England, young Riley soon developed a self-reliance and sense of responsibility that characterized him later in life. When eleven years of age he was sent to boarding school in France, and later to Germany. His familiarity with these languages was of invaluable service to him in his professional life, as he spoke both with exceptional accuracy.

It appears that his views were not at all in accord with those who had encouraged him to take a classical education, as we find him, at the age of seventeen, setting sail for New York, where he arrived after a seven weeks' voyage with little means and "a stranger in a strange land." That young Riley was of a practical turn of mind was again exhibited after his arrival here from the fact that he settled upon a farm in Illinois where he remained for four years until he had acquired an experience of practical agriculture. He then went to Chicago, where he took up journalistic work, drawing portraits, and at the same time paying special attention to botany and entomology. Finally he became associated with the *Prairie Farmer*, and his writings on economic entomology were enthusiastically received by the general public. As an attache of this agricultural newspaper he attended farmers' and fruitgrowers' meetings, and soon had a large number of friends and acquaintances. It was at the meetings of the Illinois Horticultural Society that he subsequently became acquainted with Benjamin D. Walsh, a man of remarkable character and unusual ability, of English university education, who was in 1867 appointed the first State Entomologist of Illinois. They became close friends, and Walsh exercised a great influence upon Riley's future. They founded and edited the *American Entomologist*, and it was mainly through the influence of Walsh that Riley was chosen State Entomologist of Missouri, when the law was passed for the creation of that office in 1868.

He was now twenty-five years of age, and he shouldered the responsibilities of his new office with great energy and enthusiasm. The golden opportunity of his life had now come, and before he had completed the last of his now famous nine Missouri Reports, he was recognized, not only in this country, but in all parts of the civilized world, as the foremost living economic entomologist.

These reports are based almost entirely upon original observations, and are replete with original drawings of life-like characters of marvelous scientific accuracy. This remarkable work was accomplished single-handed, and in a field that was distinctly his own. It has been called epoch-making in its character, and any one reviewing this pioneer work must admit that it is the product of a master—a most extraordinary man.

Through his efforts the United States Entomological Commission was established by Congress in 1876, and his services in connection with this commission as its Chief were of great value to the general agricultural public. He accepted the position of Entomologist to the Department of Agriculture in 1878, but gave up the place shortly afterward, retaining, however, his connection with the Entomological Commission, and continued his work for the government.

When the Division of Entomology of the Department of Agriculture was created in 1881 Professor Riley was placed at its head, a position which he held continuously until the time of his resignation, in 1894, on account of impaired health. His influence in the Department of Agriculture was very great, and he was the prime mover of many important reforms.

He was a member of many scientific and agricultural societies in this country, and always took an active part at the meetings of the Society for the Promotion of Agricultural Science from the time he joined it in 1882. He was also an honorary member of many foreign societies.

After his resignation from the Department of Agriculture in 1894 it was his intention to have devoted himself solely to pure scientific research. In 1896 he gave his collections of insects, comprising about 20,000 species, which represented over 115,000 pinned specimens and other material, to the United States National Museum, Department of Insects, of which he was Honorary Curator. Had Riley lived, no doubt the greatest work of his life would have been produced in his later publications.

REVIEW OF THE
ENTOMOLOGICAL FEATURES OF 1896.

Immediately after assuming charge of the Entomological work of this State on July 1st, 1896, I began an inspection of the orchards and nurseries in accordance with the provisions of the Trees and Nursery Stock Law, Chapter 290, Laws of Maryland, 1896. I found very soon that the San Jose scale was very widely distributed throughout the State, and that considerable damage had been done to bearing orchards in several counties. This work is reported in detail at another place in this report.

Next to the San Jose scale, the melon plant louse, *Aphis gossypii*, caused more damage in our State than any other insect the season of 1896. Hundreds of acres of canteloupes were destroyed by it in Baltimore, Anne Arundel, Prince George, Charles, Calvert, St. Mary's, Wicomico, Dorchester and Somerset Counties the latter part of June and early in July. After making a number of preliminary tests, we found that under spraying of the leaves with kerosene emulsion, diluted with 20 parts of water, was the most convenient method of treatment.

Anticipating a repetition of this outbreak in 1897, I prepared and published Bulletin No. 48, of this Station, in which I gave an account of the habits and life history of the melon plant louse, together with suggestions and remedies for its destruction and control. This bulletin also contained an account of several other injurious species of plant lice which are common in this state.

The asparagus beetle, *Crioceris asparagi*, was exceedingly abundant and destructive over a large part of the state. I saw large numbers of larvae on asparagus in Kent, Dorchester, Montgomery and Washington Counties during the month of August. The 12-spotted species, *C. 12-punctata*, was also quite common throughout these counties, but not nearly so abundant as the foregoing. The spotted species, however, seem to be increasing to a considerable extent, especially in the counties where asparagus is grown over large areas. I am of the opinion that it will become as serious a pest as the old species in the near future.

The potato stock weevil, *Trichobaris trinotata*, did considerable mischief to potatoes in Baltimore and Howard Counties. August 10th I inspected potato fields in the vicinity of Greenwood, Baltimore County, at the solicitation of J. G. McComis, and found that nine-tenths of the vines had been killed by this insect. Nearly every stem contained one or more larva or pupa. Later observations throughout other parts of the state, especially in lower Washington and upper Montgomery Counties, I found that the same insect was doing considerable damage.

The Colorado potato beetle, *Doryphora 10-lineata*, and the blister beetle, *Epicauta cinerea*, also did great damage over a large portion of the state.

Cabbage especially, suffered severely from the attacks of the cabbage worm, *Pieris rapae*, the cabbage Plusia, *Plusia brassicae*, and the Harlequin cabbage bug, *Murgantia histrionica*, over the entire State. This latter insect being of considerable importance and gaining in numbers over the state. We will give a detailed account of it, with illustrations of its various stages in a bulletin to be published this fall.

The strawberry weevil, *Anthonomus signatus*, appeared in great abundance the early part of the season, and was especially injurious to certain early varieties. The greatest damage was done in Anne Arundel, Baltimore, Caroline and Somerset Counties.

The plum curculio, *Conotrachelus nenuphar*, concentrated its attacks upon peach, and did great damage to pear in the tide-water section of this state, much of the former fruit ripening prematurely and falling from the trees.

The codling moth, *Carpocapsa pomonella*, was especially conspicuous in the apple-growing sections of the state, and did considerable damage.

The imported elm leaf beetle, *Galerucella luteola*, was very abundant on English elms throughout the state, and many trees were completely defoliated by the larvae of the first brood. The most serious effect was noted, however, later in the season, as the second brood were reaching maturity.

Another insect which is making considerable headway in this state as a shade tree defoliator, is known as the locust leaf beetle, *Odontota dorsalis*. I saw the ravages of this pest in all the lower Counties of the state, especially those bordering the water ways. In many instances the trees scattered over large areas had their leaves completely seared and were as brown as if they had been burned.

In September I found the army worm, *Leucania unipuncta*, very abundant near Berlin, Worcester County. In some fields, corn had been stripped of its blades, nothing being left except the mid-rib. Millet had also been injured to a considerable extent. September 17th, the worms were abundant in corn shocks that had been recently cut on the farm of R. C. Peters. I also noted the ravages of the insect in Washington County above Hagerstown, near Chewsville, September 12th. The principal damage was done to millet, although grass and corn were injured to some extent. September 10th, Randolph Humphreys, of Salisbury, Wicomico County, sent specimens of this insect to the College for examination. He stated that the pest was doing much damage in his County.

The Hessian fly, *Cecidomyia destructor*, was not uncommon in Washington, Howard, Montgomery and the Southern Counties. In St. Mary's County, wheat planted as late as October 8th to 18th was badly attacked. In Washington County the insect was worse in wheat planted previous to September 20th. I could find little or no fly in fields sown between September 25th and October 1st. A bulletin, giving a detailed account of this insect, with suggestions for its control, is now in press.

ENTOMOLOGICAL FEATURES OF 1897.

The first insect that attracted any considerable attention throughout the state during the season of 1897 was the clover leaf weevil, *Phytonomus punctatus*. The larvae were first observed by me here at the Station on crimson clover April 14th, but no complaints of injury were reported to me until April 22d, at which time H. O. Devries, of Marriottsville, Howard County, wrote me that they had appeared in clover fields in his vicinity, "with renewed vigor." Other reports came almost daily of their arrival in great abundance in the counties of Montgomery, Howard, Washington, Frederick, Carroll, Harford, Baltimore, Anne Arundel and Prince George. I found here at the Station April 19th several larvae of a creamy color attached to leaves; although still living, they were unable to move. I made a careful examination of them, and came to the conclusion that they were being destroyed by the fungus, *Empusa* (*Entomophthora*) *sphaerosperma*, often found on this species. From April 19th to May 12th the disease seemed to increase in intensity, and it was not an uncommon thing to find four or five dead larvae flat on the surface or curled about the edges of a leaf. They were also on the heads of clover stems, timothy, weeds and grass; in fact, anything that projected above the surface of the ground. By May 15th it was almost impossible to find a single living healthy larva, and by the 20th they had disappeared. The disease was wide spread throughout the counties above mentioned, as shown by personal inspection or examination of material sent to me.

Next in order came several species of flea beetles. A little blackish species, *Chaetocnema pulicaria*, was particularly abundant and destructive to young corn from May 6th to May 25th. They were very numerous on sugar corn and on field corn, completely ruining the first plantings in parts of Prince George, Anne Arundel, Howard, Montgomery, Kent and Worcester Counties. Another species, *Epitrix cucumeris*, was also very destructive to young potatoes, and was most abundant from May 15 to the 21. Tobacco was slightly injured by still another species, *Epitrix parvula*, the first ten days in June.

The potato stock borer was also again very abundant in upper Baltimore County, and did much damage to the early potatoes. The injury, however, was not so severe as that recorded last year.

In the tobacco growing counties of the state tobacco was very badly attacked by cut worms the early part of the season, and later by the tobacco worm, or hornblower, *Sphinx carolina*. Several experiments were performed with a poisonous mash for the destruction of the cut worms, the results of which have been published in Bulletin No. 55 of this Station. Other experiments were also conducted with the view of attracting the parent insects of the second brood of tobacco moths to a trap which had been set in the field, and in which sweetened materials, previously poisoned, had been placed, The experiments are not yet complete, and the results will be known as soon as possible.

Here at the Station I found the larvae of a beautiful little moth, *Pyrausta ferrugalis*, injuring the young tender lower leaves of tobacco in the hot bed. The larvae were abundant from July 1st, affecting usually the under side of the leaves, cutting irregular holes. When full grown, many larve cut two slits in the side of the leaf, doubled it over, and pupate within, while others transform between the leaves where they happen to be close together. The moth emerged in my breeding cages from July 6th to July 13th, the greatest number having appeared July 9th. They were most abundant on plants in the beds July 13th. They hide on the under side of the leaves, and are easily disturbed, flying quickly when approached and running rapidly to the under surface of the leaf when alighting.

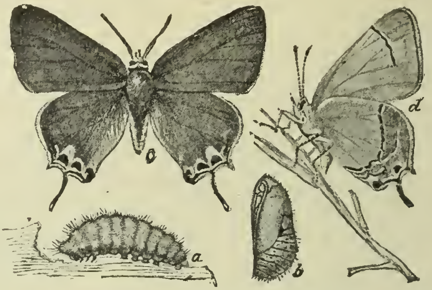

Figure 1.—Uranotes melinus. (From Howard in Insect Life.)

I found also here at the Station another insect feeding upon lima beans July 13th, which is not a very common species in this state. The insect is known as *Uranotes melinus*. The larvae are somewhat slug-like in general appearance, as shown at *a* in Figure 1, and cut holes into the pods and feed upon the beans within. Many pods were found that had been perforated and the beans extracted, but no larvae were seen in them. They are very sluggish worms, and not easily disturbed. One was placed in a breeding cage, where it pupated July 15th from which the adult butterfly emerged July 29th. Other larve were found on the beans July 28th in the same plot, and from these a number of natural parasitic enemies, *Apanteles limenitidis,* Riley, were bred August 7th.

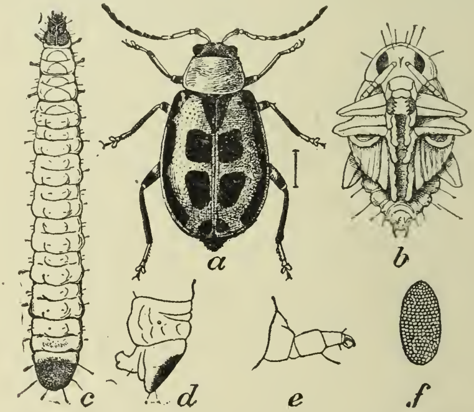

Figure 2.--Cerotoma trifurcata. (From Chittenden Bulletin, No. 9, n. s. Div. Ent.)

The bean leaf beetle, *Cerotoma trifurata,* was also observed by me May 19th in a patch of wax and lima beans near the Station. My attention was attracted to the ragged appearance of the leaves. Upon examination I found the insect, shown at Figure 2, in great abundance on the plants. The wax were more severely injured than the lima beans, nothing but the mid rib of the larger vines being left upon some leaves. The insect is easily disturbed, and drops quickly to the ground and hides when approached. The attack in this patch was local, as no beetles were found at other places in the vicinity. The ground where the outbreak occurred was surrounded last fall with cow peas, and it seems quite pos-

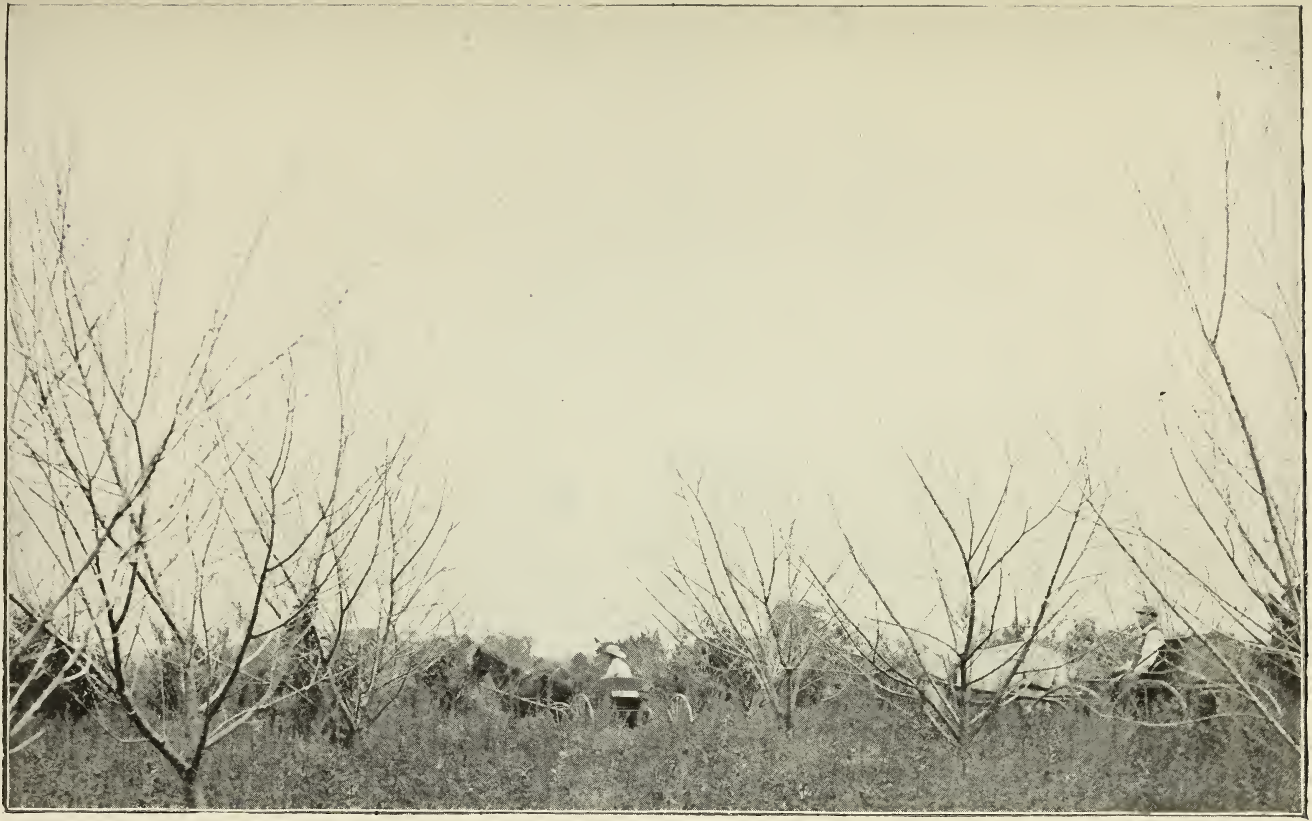

Figure 3.—View in a Maryland peach orchard of 28,000 trees killed by the San Jose scale. From a photograph taken in mid-summer (August 6, 1897), by W. G. Johnson.

sible that the beetles bred there in considerable numbers during the spring and concentrated upon the beans nearby later. Beetles, presumably of a second brood, were common on plants in the garden July 16th.

The corn crambus, *Crambus caliginosellus*, appeared in destructive numbers the early part of the season in Prince George, Cecil, Kent, Queen Anne and Dorchester Counties. In July Mr. F. H. Eldridge, of Ceciltown, Cecil County, sent specimens of the larvae and work of this insect to the Station, stating that it was doing great damage to corn on his place. July 20th I examined the corn on this farm, and found that about twenty-five acres had been completely ruined by the pest, even after the fourth planting. The young corn was perforated and eaten just below the surface of the ground, and in many instances was cut entirely off. My attention was frequently called to the ravages of this pest at the meetings of the Farmers' Institutes. A bulletin giving an illustrated account will appear this fall on this and other corn insects.

The rose bug, *Microdactylus subspinosus*, which has been a very destructive insect in the lower counties of this state for many years, appeared in large numbers the early part of June and did considerable damage to the grape crop, especially in the southern counties of the Eastern Shore. Great injury was also done by this pest to roses. In some instances peaches were attacked and injured. A series of experiments were conducted during the season, the outcome of which has not been entirely satisfactory, and will be repeated.

The pear psylla, *Psylla pyricola*, which has been very destructive to pears in certain sections of New York for a number of years, appeared in several localities in rather limited numbers in Kent County, but no serious damage was done. This is an insect which is capable of doing very great damage in a pear orchard, and close watch should be kept for it throughout the state. It is an exceedingly small insect, and occurs in such great numbers that trees, as well as the fruit, are very often badly discolored by a blackish fungus, which grows upon a sweetish liquid known as honey dew the insects exude from their bodies. Trees badly infested with this insect become sticky and gummy and soon covered with the fungus, giving them the appearance of having been dusted with soot.

In May a small beetle was found doing considerable injury to young strawberry plants near Lake Shore, Anne Arundel County. A careful examination of the creatures showed that two species were represented, *Graphops marcassitus* and *Typophorus* (*Paria*) *canellus*, and responsible for this injury. The former species is closely related to an insect which has been known to do considerable injury to strawberries in the west, and is popularly known as the strawberry root-borer, *Graphops nebulosus*.

The most prominent orchard pest during the season of 1897 was the plum curculio, which appeared in great numbers the early part of the season, and did great damage to the peach crop, especially on the Eastern Shore and tide-water section of Western Maryland. I estimated that fully one-half of the crop had been destroyed by this insect in the tide-water section of the peach-growing belt. Its absence in Western Maryland or the Blue Ridge peach belt was especially conspicuous. The orchards in that section are younger and have received better attention during the last few years than those in lower and Eastern Maryland. This same insect also did considerable damage to pears and apples, as well as plums and peaches.

The striped cucumber beetle, *Diabrotica vittata*, appeared in considerable numbers during the early part of the season and occasioned much correspondence. Its ravages were confined particularly to canteloupes and cucumbers, although water melons and squash vines were also injured to a considerable extent.

The Harlequin cabbage bug and the strawberry weevil appear over large areas of the state in usual numbers the early part of the season, and great damage was done to the cabbage and strawberry crops. A series of experiments were conducted during the season on the latter insect, and will be included in my next annual report.

The melon plant louse and other species of plant lice, particularly *Aphis brassicae*, *A. prunicola* and *Myzus cerasi*, appeared in great numbers and occasioned much loss.

Another insect, not usually seen in this state, was bred from larvae found boring in the stems and larger branches of *Cosmos bipinnatus*, growing here on the Station grounds. The larvae were obtained from the heart of the green stem of a plant August 22d. All the branches had been burrowed out to such an extent that they were easily broken off; in fact, a slight wind readily broke the plants, and it was this that first attracted our attention. Larvae were placed in a breeding cage, and one of them pupated August 25, from which the adult insect emerged September 30th, which proved to be *Hydroecia marginidens*. These observations were of especial value, from the fact that the food plant of this insect was not heretofore known. The hollowing out of the stems and branches of the cosmos does not seem to injure the plant, so far as growth and blooming are concerned, but the difficulty arises from the weakening effect the insect has upon the plants, causing them to break readily in a slight breeze.

The fly weevil or Angoumois grain moth, *Sitotroga cerealella*, caused considerable damage to stored grain throughout the southern and eastern portion of the state. This insect has been particularly destructive to wheat and corn. A more detailed account of it, together with another insect which has done considerable damage to stored grain in this state, known as the grain or rice weevil, *Calandra oryza*, will be found in my next forthcoming report.

Notes and observations have been made upon many species of scale insects and other insects throughout the state, but it will not be possible to give an account of each species in this report, as I have now in preparation a bulletin in which I shall give a detailed account of the scale insects in Maryland, which will be published some time this winter.

THE SAN JOSE SCALE.

Aspidiotus perniciosus Comstock.

INTRODUCTION.

The San Jose scale (pronounced San Ho-zay) has caused more damage to orchards in this State than any other insect. It has been gradually spreading for the past six or seven years, and not until 1897 was there any perceptible reduction in the number of infested trees. During that year, as will be shown later, many thousand trees were destroyed and the insect was reduced to a minimum.

After making a most careful review of the damages in other States, I can safely assert that the losses sustained in Maryland by this insect have been far greater than in any other State except California. This is due, I believe, principally, to two causes: First, on account of our peculiar geographical location, we have been receiving infested nursery stock from the infested centers almost annually since its introduction into the East; and secondly, on account of its early establishment in some of our largest peach orchards, where it was silently at work several years before it was discovered.

Even in the light of all the damage that has been done here, there are many persons, and some of them professional men, who look upon the San Jose scale with an eye of unconcern and indifference. I do not wish to present this terrible pest any worse than it is, but if a person, even the most skeptical, can look at Figures 3 and 4 and read the account of this outbreak, and then reaffirm that there is nothing to fear, I am willing to make the assertion that such a person is not a capable judge to pass an opinion.

No single insect pest in this country has caused as much concern on the part of nurserymen and fruitgrowers. In my opinion, basing my statements on six years' observations and experience, the San Jose scale is the most pernicious orchard pest established in the United States. It can be controlled, however, if taken in time; but with much difficulty. The principal source of danger is the nursery, and we now have it in complete subjection in this state where it was discovered.

So much has been said and published regarding this insect by persons who have had little or no experience with it, I have considered it wise to give the opinions of several of Maryland's most successful fruit growers, whose experience with it has been such that they know about what they are talking. I shall first quote, however, what Dr. L. O. Howard, the United States Entomologist, says on this point in his bulletin (Bull. No. 3, n. s. Div. Ent. Dept. Agr.).

He says: "There is perhaps no insect capable of causing greater damage to fruit interests in the United States, or perhaps the world, than the San Jose scale. We are, therefore, justified in the assertion that no more serious menace to the deciduous fruit interests of this country has ever been known."

As this was written in the fall of 1895, I wrote Dr. Howard, November 8th, 1897, asking whether or not he had any reason for changing this paragraph from recent developments and experiments with the San Jose scale, and received the following reply November 9th: "I have seen no reason to alter the paragraph which you mention on account of any recent experience with the San Jose scale."

Mr. Robert S. Emory, of Chestertown, one of the largest and most successful fruit growers in the east, says: "I have been a fruit grower all my life, and in all my experience I have never had to contend with such a persistent, deadly enemy as the San Jose scale. It costs me annually more hard work and cash outlay than all the other insects of the orchard combined. I consider it the worst orchard pest ever established on American soil."

Mr. George K. McGaw, one of the owners of the orchards shown at Figures 3 and 4, wrote December 20th, 1897, as follows: "I cannot imagine a more deadly destructive enemy to peach trees than this insect. The 28,000 fine, healthy peach trees in our orchard two years ago, at present evidences the penalty we have paid to its introduction into this state."

Mr. Samuel H. Neikirk, of Washington county, in a letter January 18th, 1898, says: "I have never seen or heard of any orchard pest to equal this destructive creature."

Mr. Elymet Dows, of Charles county, says in a letter dated November 29th, 1897: "I very much fear this pernicious insect will ruin the fruit industry of the state.

Mr. Charles G. Biggs, of Sharpsburg, writes November 26th, 1897, as follows: "In my opinion an orchard is rendered practically valueless in three years after the scale is thoroughly established in it. While the tree may retain sufficient vitality to bear a year or two longer, the fruit itself will be so damaged by its depredations, that no self-respecting grower would want to put it upon the market, as his reputation would soon be destroyed."

Mr. L. A. Palmer, of Anne Arundel county, November 29th, 1897, says: "I know of nothing so destructive to fruit trees as the San Jose scale; besides, I am satisfied it will spread over a whole orchard in two seasons, if not checked."

Mr. James Bond, of Baltimore, who lost a large orchard from the attacks of this insect, writes November 11th, 1897, as follows: "My peach orchard before the pest attacked it was an exceptionally handsome and vigorous one, but when I looked it over this fall, it plainly showed that it was in the hands of a natural and vigorous enemy."

Mr. J. P. Blessing, a successful fruit grower in Washington county, writes December 2nd, 1897, as follows: "I regard the San Jose scale as the most dangerous insect of which I have any knowledge, and more to be dreaded than even the yellows by peach growers."

Mr. Thomas R. Hubbard, of Dorchester county, wrote me December 11th, 1897, as follows: "My opinion of the scale, as far as my limited experience will allow, is, that it is to be dreaded more than all other enemies of the orchard combined."

Many other opinions could be cited, but these will suffice to show that this insect is regarded as a serious and dangerous pest by those who have had to combat it in their orchards. I will now turn my attention to the subject in a general way, under the following heads and sub-heads:

PAST HISTORY.

This insect was first discovered and brought to the attention of the scientific public in 1880 by Professor J. H. Comstock, now of Cornell University, who was at that time United States Entomologist. He first discovered it in the extensive fruit orchards of Santa Clara County, near San Jose, California, in 1879. Referring to the deadly nature of this pest in his report (U. S. Department Agr., 1880), Professor Comstock says: "From what I have seen of it, I think it is the most pernicious insect known in this country; certainly I never saw another species so abundant as this is in certain orchards which I have visited. It attacks the bark of the trunk and limbs as well as the leaves and fruit. I have seen many plum and apple trees upon which the fruit was so badly infested that it was unmarketable. In other instances, I have seen the bark of all the small limbs completely covered by the scales. In such cases the wood beneath the bark is stained red."

While in California Professor Comstock collected a quantity of twigs infested with this insect and brought them to Washington for further study. Upon examination he found the scale was new to science, and gave it the very suggestive and appropriate scientific name of *perniciosus*, describing it in his important paper on scale insects, published in the report cited above. Popularly, he proposed to call it "the pernicious scale," and so recorded it; but from the fact that his original observations were made in the vicinity of the city of San Jose, and that the orchards in that locality were especially badly infested, the pest was soon known to the general public as the San Jose scale.

It was thought for sometime that it was introduced into California, in the neighborhood of San Jose, about 1870, by the late James Lick, upon a lot of fruit trees from Chili. About that time the same gentleman, who was much interested in forestry and fruit culture, introduced a lot of trees from Japan, and it has been asserted that the scale was probably introduced from that country. In Chili, where the pest has been found, it is asserted that it came from trees introduced from the United States. We, therefore, have no direct evidence that the importation into California came from Chili. It has been found very recently (January, 1898,) on trees from Japan (Ent. News, Vol. IX., pp. 95-96), and two very closely allied species have also been discovered there within the past two or three years. It is quite probable, therefore, that Japan may yet prove its native haunt, but if this proves true, why is it that the scale is not nearly as abundant and destructive there as here? Is is possible that some natural enemy is keeping it in check, which has not been introduced into this country? If so, then that natural enemy, whatever it may be, if established in this country, may do for the San Jose scale what the Australian ladybug did for the cottony cushion scale in California a few years ago. It is certainly worthy of investigation.

The original home of the San Jose scale is, therefore, still in doubt.

There can be no question, however, about the introduction into the Santa Clara Valley about the time specified, but it would not be good policy, from the data we have on hand at present, to state that it came from any one particular country. Eastern Asia, China, Japan, Australia or some of the islands of the Pacific may have been responsible for it.

DISCOVERY IN THE EAST.

The San Jose scale was not known in any nursery or orchard in Eastern United States previous to August, 1893. At that time, it was discovered at Charlottesville, Va. It had become established in the orchard of Dr. C. H. Hedges, who sent specimen twigs cut from the infested trees to Dr. B. T. Galloway, Chief of the Division of Vegetable Pathology, United States Department of Agriculture at Washington; thinking that the trees were affected by a fungus disease. The twigs were referred to the Division of Entomology, and Dr. L. O. Howard immediately recognized that they were infested with the dreaded San Jose scale. Upon further investigation it was found that the trees came originally from a New Jersey nursery, and a later examination of the nursery showed that the pest was thoroughly established upon the stock growing on the place. Every effort possible was made to destroy the scale at Charlottesville, in order that it might not spread to other orchards in the vicinity; but I am informed that it still exists there to a limited extent at the present time.

Very many other infested localities were discovered shortly after this announcement, including the nursery of J. T. Lovett, Little Silver, N. J., and it was soon found that the pest was very widely distributed. From the fact that it had originally gained a foothold in two prominent New Jersey nurseries, it was disseminated widely on nursery stock throughout the East.

Regarding the original introduction of the scale in the East, I quote from Bull, 3, n. s., p. 15, Div. Ent. U. S. Dept. Agr. by Howard and Marlatt, as follows: "The two nurseries responsible for the original eastern introduction of the scale, are near Burlington, N. J., and Little Silver, N. J., the one on the Delaware River, and the other on the Atlantic coast. The scale was introduced into these two nurseries in the same way. Either in 1886 or 1887, in the endeavor to secure a thoroughly cuculio-proof plum, both of these nurseries introduced from California an improved Japanese variety, the Kelsey, obtained from the San Jose district. We have the statement from the proprietors of one of the nurseries that the plum trees in question were secured in the spring of 1887 from San Jose, Cal., and were shipped through the agency of a Missouri nursery company, which acted at this instance apparently as a mere transmitting agent. The trees were unquestionably thoroughly infested when received, did not thrive, and in both cases most of them were ultimately taken out and destroyed. The stock, however, had been multiplied by nursery methods, and from the original stock, and that subsequently obtained, the scale spread more or less completely throughout both of the nurseries in question.

"In the case of one of the nurseries the scale spread to bearing pear trees, and from these had spread yearly to neighboring nursery trees. In the other nursery, fruit-growing is quite an important feature, and the scales had spread early from the introduced plum trees to bearing trees, and also infested low shrubs and plants, particularly currants of both the black and white varieties. It spread finally more or less thoroughly throughout large blocks of nursery stock. Both of these firms, when the nature of the infestation was brought to their attention undertook measures to exterminate the scale. One of the nursery companies was particularly prompt and thorough in its efforts in this direction, and deserves great credit for the manner in which it undertook the work; the other was for a time dilatory and seemingly indifferent, but was forced by the necessities of its business and by public opinion to adopt similar remedial measures."

Later investigations showed that it was also established in a number of large nurseries in widely separated states. A year after its discovery at Charlottesville, it was located in eight states. By the summer of 1895 the number had increased to fourteen, and in nearly every case the insect was traced to one of the two nurseries in New Jersey. Many new localities have been added since then, and (see Bull. 12, n. s. Div. Ent, U. S. Dept. Agr.) the insect is now known to have established itself in 33 states, including the District of Columbia, as follows: Alabama, Arkansas, Arizona, California, Connecticut, Delaware, District of Columbia, Georgia, Idaho, Illinois, Indiana, Kentucky, Louisiana, Maryland, Massachusetts, Michigan, Minnesota, Mississippi, Missouri, Nevada, New Jersey, New Mexico, New York, North Carolina, Ohio, Oregon, Pennsylvania, South Carolina, Tennessee, Texas, Virginia, Washington and West Virginia. There is little or no doubt but what later investigations will bring to light new localities, as the pest seems to be very generally distributed throughout nearly the whole of the United States, and has been found in Canada and British Columbia.

DISCOVERY IN MARYLAND.

The first intimation of the presence of the scale in Maryland came to light in March, 1894, at which time Elymet Dow, of Riverside, Charles County, submitted specimen twigs infested with this scale to Dr. Howard for examination. In May of the same year another place was discovered near Neavitt, Talbot County, in the orchards of J. H. Reip. Still two other localities were determined in July of that year, near Chestertown and Still Pond, Kent County, the former in the extensive orchards of R. S. Emory, and the latter in the orchards of J. S. Harris. In November, it was found in the large orchards of Charles G. Biggs, near Sharpsburgh, Washington County, and a month later it was located at Frederick, Frederick County, and Mitchellville, Prince George County.

In January, 1895, Robert L. Gulick found it in his experimental orchards in Dorchester County. It was located at West River, Anne Arundel County, in April of the same year; at T. B., Prince George County, in August, and in another orchard near Sharpsburg in November. The aforegoing eleven localities were all that were known in this state previous to 1896.

In January, 1896, F. C. Pratt, an assistant of the United States Department of Agriculture, discovered a few infested trees near Berwyn, Prince George County. From July 1st, the time I assumed charge of the state work, to December 16th, I added eight new localities, as follows: Westminster, Frederick, Burkittsville, Mt. Lake Park, Jerusalem Mills, Ednor, Barnesville and Easton. During the year 1897 I have added to this list twenty-seven more infested districts, all of which are enumerated by counties in this report. For the first three months of 1898 that is, January, February and March, I have found fourteen more localities, and I am of the opinion that others will follow as the work progresses.

SOURCES OF INFESTATION.

From the detailed account which follows, it will be seen that the scale has established in eighteen counties out of the twenty-three in the state, representing fifty-eight localities, and involving ninety-five premises. In fifty-nine instances the source of the infestation is easily traceable to the nursery from which the trees were originally purchased. Twenty-six orchards or premises have become infested from scale-covered trees in their immediate vicinity, leaving ten orchards where there is some doubt as to the real source of the scale. It is not an uncommon thing to find trees planted in an orchard coming from three to four or more different nurseries, representing as many states, and all planted about the same time. It is, therefore, difficult to say with any degree of certainty who was responsible for the introduction of the pest under such conditions, especially where the trees were standing several years before the scale was discovered upon them.

While we know with certainty the names of most of the nurserymen who have distributed scale-infested stock in this State, it does not seem wise, indeed, it would be unjust, for us to publish their names in this connection. Such publicity would be productive of no good whatever, and would do harm to the trade in general. The nurserymen who have sent out stock infested with San Jose scale do not necessarily have that pest in their nurseries. Many cases of infestation in this state are due to stock that has been rehandled. Neither can we say that a nurseryman, who may have had the scale on his place a year or more ago, has it at the present time.

Whenever an infested tree is found all the facts concerning it are ascertained, so far as possible, and the nurseryman who is suspected is duly notified and warned. With few exceptions, the nurserymen or dealers who have sent out the San Jose scale, have done it unwittingly, and have been ever ready to cooperate with us in its control and suppression when the matter was called to their attention.

The scale is now so generally distributed in orchards, and has been discovered in so many nurseries throughout the United States, the purchaser of nursery stock, from whatever source, should be on his guard, and carefully examine every tree that comes upon his place, even though it bears a certificate of inspection.

Scale-infested nursery stock has been brought into Maryland during the last ten years from eight different states, as follows: New Jersey, New York, Virginia, Pennsylvania, Missouri, Ohio, Georgia and California. Of the infested districts, New Jersey has been responsible for

24, Maryland 19, New York 5, Virginia 3, Pennsylvania 3, Missouri 2, Ohio, Georgia and California 1 each. In 1888 there were five importations of scale-infested stock into the State; 4 of them from New Jersey and 1 from Missouri; in 1889 there was one case from New Jersey; 1890, 1 from California, 3 from New Jersey, 4 from Maryland and 1 from New York; 1892, 2 from New Jersey, 2 from Maryland, 2 from Virginia, 1 from New York and 1 from Pennsylvania; 1893, 3 from New Jersey, 3 from Maryland. 2 from New York, 1 from Virginia and 1 from Georgia; 1894, 5 from New Jersey, 2 from Pennsylvania and 1 from Missouri; 1895, 2 from New Jersey, 5 from Maryland and 1 from New York; 1896, 4 from New Jersey, 4 from Maryland and 1 from Virginia; 1897, 1 from Ohio and 1 from Maryland.

Owing to the present wide distribution of the scale it is hard to say that nursery stock is above suspicion coming from any source.

PRESENT CONDITION AND DISTRIBUTION BY COUNTIES.

ANNE ARUNDEL.

Parole:—My attention was first called to this outbreak by the owner of the orchard, Mr. L. A. Palmer, who stated at a meeting of the Farmers' Institute at Annapolis, February 25th, 1897, that he was of the opinion the San Jose scale was thoroughly established in his orchard. He said his trees consisted mostly of Dwarf Duchess pear, and that they had been declining and dying in spite of careful cultivation, and frequent mulching with manure and fertilizer, ever since they were planted six years ago, until at present not more than a dozen trees remained out of sixty originally planted. By request, Mr. Palmer sent specimen twigs to the Experiment Station for examination three days later. As anticipated, they were literally covered with the San Jose scale. I inspected the orchard March 13th, and found only nine trees of the original planting still standing, and these so literally covered with the scale it was impossible to see the bark at any one point. The other trees had died and had been dug up. A few plum and cherry trees and several currant bushes, bought and set out at the same time, were also found infested with the scale. The former were planted along a fence adjoining the pear orchard, while the latter were set out between the rows. The most of the currant bushes had died, and those still standing were so covered with the scale it was thought best to grub them out and burn them. I also suggested that it would be wise to destroy all the other bady infested trees and spray the plum, cherry and a few ornamentals near by with whale oil soap.

I could find no traces of the scale in the vicinity upon any other trees. There is no doubt in my mind but what the pest was introduced upon a few trees at the time they were purchased, and gradually spread from year to year until the whole orchard became infested.

In reply to an inquiry about the present condition of the orchard, Mr. Palmer sent me the following letter November 29, 1897: "The number of Duchess pear trees I purchased was 65, but I am of the opinion that the San Jose scale first made its appearance on two mountain ash trees, purchased from the same company and at the same time. They were planted near the pear trees. The pear trees were looking healthy and producing fruit until I dug up the mountain ash trees. The following spring I noticed that the scale had spread to all the pear trees. I know of nothing so destructive to fruit trees as the San Jose scale; besides I am satisfied that it will spread over a whole orchard in two seasons if not checked. I have not fully succeeded in exterminating the pest from my place, but think I will be able to this coming winter. I think it one of the most deadly enemies with which the horticulturalist of this state have to contend."

Crownsville:—The infestation here is in the heart of one of the largest, if not the largest, apple orchards in the state. My attention was called to it March 25th, 1897, by the owner. Dr. H. L. Mann, of Washington, D. C., who brought specimens to my home. He had first submitted the twigs to Prof. M. B. Waite, of the Division of Vegetable Physiology and Pathology. United States Department of Agriculture. who referred him to me. I visited the place March 27, and in company with Dr. Mann and his brother, N. A. Mann, who resides on the farm, made a partial inspection of the orchard, which covers about one hundred and forty acres, consisting principally of apple, a few peach, pear and plum. On the whole, the orchard was in fine condition, and the trees, two years old, had made a remarkably good growth. During the fall of 1896, Mr. N. A. Mann had noticed that several apple trees in the Ben Davis block were not perfectly healthy, and had called his brother's attention to the fact; but the matter was overlooked, and nothing further was done until the latter part of March, at which time Dr. Mann was taken to the trees, several of which had died.

A careful inspection of the orchard showed the scale was pretty generally distributed over it. Eight Ben Davis apple trees very badly infested were found in one row. Two were dead, two so literally covered that little life remained. Several trees in the rows immediately adjoining on the east and southeast, the direction of the prevailing wind, were found infested. At another place, several hundred yards away, a tree was found thickly encrusted with the pest, and from this as a center it had spread to other trees in the vicinity. A tree here and there was found throughout the orchard that contained the scale. I also examined a large number of peach, pear and plum of many varieties, but found the scale on nothing except the apple.

The infested trees were pulled up as soon as they were discovered, and part of them were brought to my laboratory for experimental purposes. The trees in the vicinity of the infested ones were sprayed with whale oil soap. There were no old trees or orchards in the neighborhood that had any trace of the scale upon them. Our general conclusion was, therefore, that the pest had been introduced upon the trees from the nursery.

West River:—In their bulletin (No. 3, n. s. Div. Entom. Agri. Dept.) Howard and Marlatt state that their attention was called to the presence of the scale at this place April 25th, 1895; but no details are given as to the extent of the attack. I, therefore, wrote Mr. N. S. Chew, the owner of the orchard, November 17th, 1897, and asked for a brief account of the outbreak.

He informs me that the pest was introduced upon the stock from the nursery, and that he made a persistent and energetic fight by spraying to subdue it, but did not succeed, as indicated in his letter which I quote, in part, below. He says that he used whale oil soap, "one pound to a gallon water," common hard soap, kerosene emulsion, and on one tree spirits of turpentine. In all, his spraying has not been satisfactory, due possibly to the fact that the solutions were not used strong enough. Whale oil soap, for instance, must be used at not less than two pounds to a gallon of water to be at all effective in the destruction of the scale, and it is even then uncertain, as mentioned in another place under remedial measures.

In his letter dated November 23d, 1897, Mr. Chew says: "Yours of the 17th instant at hand and noted. In the spring of 1892, I planted a small orchard of peach, apple, cherry, plum, pear and apricot trees, in all about 250. During that season I noticed what was afterwards pronounced San Jose scale. It first appeared on some Japan plum trees, Burbank and Satsuma, spreading rapidly to apple trees near them. As soon as I found out that it was San Jose scale I dug these trees up and burned them, but too late, as the peach trees had become infested. I tried spraying with whale oil soap, one pound to the gallon of water, without satisfactory results. It spread so rapidly that I have been compelled to dig up the whole orchard. I am sure the Japan plums were infested when received. I have not heard of the scale being any where else in the neighborhood."

Lake Shore:—The infestation at this place was brought to our attention by the owner of the orchard, James Bond, of Baltimore, who sent a specimen pear and a peach twig to Professor Robinson for examination. The material was referred to me September 20th. After some correspondence with Mr. Bond, he has furnished me the following facts, which are given here in full. He says: "I rarely visit my farm, and my information is from Mr. John F. Ellison, who farms the place. Referring to your various questions: April 1st, 1892, I bought 500 pear trees; because of weather conditions they were not set out immediately upon receipt, but were put in the earth temporarily, awaiting an opportunity to set them in orchard. When we came to set them out we found that quite a number of them were in bad condition, and we lost about 150 of the trees. The balance, 350 trees, were planted next to peaches, at the foot of a tract known as Peach Orchard Hill, and in a patch of young raspberries. The patch of raspberries was destroyed (burned) last spring, after which the entire pear (350) and peach (900) orchards were infested. Upon examination, in company with Mr. Ellison, we concluded that the pest was so bad that the only chance of preventing its spread to neighboring orchards was to destroy by fire the entire orchard. This determination was arrived at about the 16th of October, and I assume that the destruction has been completed. Mr. Ellison has examined the other orchards and raspberry patches on my place, and failed to find any further evidences of the San Jose scale. My understanding was that you were to visit that section, and I trust you may be able to make the visit at an early day, so that we may know the exact condition. In a conversation with Mr. Ellison he informed me that the pear trees were infested when they were brought on the farm; that in searching for the cause of so many dying he noticed what he now knows was San Jose scale, but knew nothing of the pest at the time."

"I cannot now answer your question as to how many trees were killed outright by the pest. The peach orchard, before the pest attacked it, was an exceptionally handsome and vigorous young orchard; when I looked it over this fall it plainly showed that it was in the hands of a natural and vigorous enemy."

"I instructed my assistant, Mr. Sherman, to make an examination of the remaining trees on Mr. Bond's place March 2, 1898. One tree in an orchard of about 500 peach trees, five years old, was found very badly infested, and the scale had spread to the trees immediately surrounding it. A young peach orchard of about 100 trees, set out last spring near by the old infested trees, is now more or less attacked by the scale. Have advised that the young trees be given a thorough washing with whale oil soap as soon as possible.

St. Margaret's:—This locality came to my attention in February, 1898. Mr. H. A. Tydings sent me a peach twig cut from an infested tree, asking for information regarding it. The twig was literally covered with the young partially-matured females, and presented a blackish and dirty appearance. I wrote Mr. Tydings February 18th, asking more definite information regarding the outbreak, and received the following reply: February 21st. "The twig I sent you a few days ago did not come from my place, but was cut from the orchard of my neighbor, Mr. A. A. Stinchcomb. The insect seems to be confined to young trees set out last spring. The varieties affected are Troths, Early St. John, Elberta, Crawford and Smock, and were grown by Mr. Stinchcomb in his garden. There seems to be about twenty-five hundred trees affected, with other large orchards in the vicinity. Your presence is very desirable soon."

I proceeded to Mr. Stinchcomb's February 24th, and made an examination of his orchards. I found a very bad condition of affairs. He had grown about 2,500 peach trees in his garden, near his house, one year ago, and planted them in his orchard last spring. In three blocks the trees were kept together, while many others were used to replant in older orchards where the trees had died. Wherever I examined the trees I found fully one-fifth of them were infested. In some instances the bark was literally covered with the pest. After a most careful examination of the surroundings I ascertained the source of the infestation in a small apple and plum orchard in his garden. Part of the trees were purchased about ten years ago, and had made a good growth. Others had been bought from a New York firm and planted about five years ago. The majority of these trees were encrusted with the scale, some of them being dead. The pest had spread to nearly all the trees in the vicinity. The majority of them were so much stunted and reduced that no system of treatment could save them. Mr. Stinchcomb removed them, leaving only a few apple and plum trees that were moderately infested. No scales were found on a couple of English walnut trees near by.

It was clear that the scale came from these infested trees. Mr. Stinchcomb tells me that he first noticed that something was wrong with some of his young peach trees about the middle of February. He was standing in one of his young orchards, and saw a tree some little distance away that looked grayish and unhealthy. Upon examination he found it encrusted with "some kind of a creature," which he could scrape off with his thumb nail. He called the attention of his neighbor, Mr. Tydings, to the tree, and a specimen twig was sent to me as indicated above.

My suggestion was that all the trees should be examined, and wherever the scale was found upon one it should be destroyed by grubbing up and burning, as they were worth commercially only about six cents apiece, and the cost of the treatment would not pay. All the others were then to be trimmed and washed with whale oil soap before the buds began to open. Mr. Stinchcomb had a block of nursery stock, containing about 1,500 peach trees near one of these infested orchards, which he desired to plant this spring. I told him I would fumigate these trees with hydrocyanic acid gas, and arranged to do the work in a small room in a tight building near his house. The room was plastered and well adapted to the work, as explained later on. All the young nursery stock was placed in this room and fumigated. At Mr. Stinchcomb's suggestion, the entire lot of 2,500 peach trees planted last spring were taken up, examined thoroughly by my assistant, Mr. Sherman, and fumigrated March 4th, 5th and 7th. All the badly infested trees, about 500, were cast aside and used for experiment purposes or burned. The trees, about 2,000 in all, were then replanted in the orchard.

Bowie:—I found one peach tree near this place January 21st, 1898, that was slightly infested. The source of the scale could not be determined. No other trees in the vicinity and the surrounding orchards could be found that contained a trace of the scale.

South Baltimore:—The scale at this place is in the heart of a block of 600 two-year-old peach trees, belonging to Elias Stallings. Our attention was called to it in a letter to Prof. Robinson from Dr. H. M. Revell, of Annapolis, March 12th, 1898. May 14th I detailed my assistant, Mr. Sanderson, to make an inspection of the orchard and surrounding orchards. Only three trees were found infested, and, as they were in a very bad condition, it was suggested that they be taken up and destroyed. So far as could be determined the scale had not spread to any other trees in the orchard, although many of them are under suspicion, and a close watch will be kept of them during the season.

Marley:—My attention was called to another orchard in which the San Jose scale was supposed to have gained a foothold in the vicinity of South Baltimore, by Dr. H. M. Revell, of Annapolis, March 12th, 1898. I detailed my assistant, Mr. Sanderson, to visit and inspect this orchard and the surrounding premises May 18th, 1898. The orchard belongs to Mr. Frank Revell, and contains in all about 1,500 trees, mostly peach. Of these, one small orchard particularly, containing 449 trees, was found very badly infested. 136 trees were dead, 91 in a very depleted condition, while 222 were still living. A young orchard had been planted in the immediate vicinity of these trees, and the scale was also found upon the first two or three rows. In another block, containing 432 trees, the scale is quite generally distributed throughout. In another block of five or six-year-old trees, the scale is just beginning to make its appearance in the southwest corner. Immediate steps will be taken to check and control the pest at this place, and Mr. Revell has been advised that nothing will be left undone to assist him in every way possible.

BALTIMORE.

St. Denis:—While inspecting some young trees at this place August 13th, 1897, I found a box containing 4,000 King of Thompkin's County apple buds, which had been recently received from an Ohio nursery. After a careful examination of these buds, I found upon several of them unmistakable evidence of the presence of the San Jose scale, and brought the material to my laboratory, where I made microscopic mounts in order to examine and verify my identification. Although the buds were not badly infested there were enough live scales upon them to have infested any block of apple into which they would have been budded. The buds were immediately destroyed, and thus the introduction of the pest in this locality in a large nursery avoided. The nurseryman from whom the buds were purchased was immediately notified, as well as the Entomologist of that state. Upon inquiry I am informed that the scale was found scattered here and there throughout the block of apple from which the buds were cut. In justice to the Ohio nurseryman, it is but proper to say that nothing has been left undone to suppress and exterminate the pest on his premises.

Landsdowne:—A single cherry tree at Earleigh Heights, A. A. Co., was found badly infested with the San Jose scale by David Fetter in a small orchard which had been planted in the spring of 1897. A specimen twig cut from this infested tree was sent to me March 17th, and I found it very badly attacked with the scale. The tree was destroyed, and I am informed by Mr. Fetter that so far as he can ascertain with the aid of a hand lens, he has been unable to find any indications of the insect upon any of the other trees in the vicinity. Fortunately, this block contained only 19 trees. An examination of this orchard May 18th, 1898, by my assistant, Mr. Sanderson, revealed the fact, that one other tree, a pear, was badly infested, which was removed.

Still another infested orchard was discovered at this point belonging to Mr. Scott. A peach and a pear tree were thickly covered with the scale. One badly infested peach had been removed the previous week. All the trees containing scale were marked and have been removed.

Ruxton:—A twig containing scale insects was referred to this office April 19th, 1898, by Thomas J. Lea, of this place, for examination and reply. I found it quite badly infested with San Jose scale and asked for detailed information as to the number of trees in the orchard, on whose premises they were located, from whom they were purchased, and when they were set out. Not receiving a prompt reply, I detailed Mr. Sanderson to inspect the orchard May 17th, 1898. It was ascertained that the scale was located in a small orchard of about 50 trees, belonging to Mr. Vail. They had been discovered on a peach which had been destroyed. An examination of the surrounding trees showed that the pest was also established on plum and cherry in the same orchard. All the infested trees were marked, and are to be destroyed or sprayed with whale oil soap.

CAROLINE.

Greensborough:—At a meeting of the Farmers' Institute, held at Denton, January 20th, 1897, Mr. H. L. Cohee, of Greensborough, told me after looking at specimens of the San Jose scale under a microscope, that he had the same pest in his orchard, but did not know what it was. I asked Mr. Cohee to send specimen twigs to the station for examination. February 1st, a package containing several pear twigs, which came from the infested orchard, was received. Upon further inquiry, I found the trees, all pear, of the following varieties: Kieffer, Bartlett and Idaho, had been purchased and set out in the fall of 1892. Mr. J. C. Russell and Mr. J. C. Mitchell, both of Greensborough, purchased trees of the same varieties, and at the same time, and in every instance the Idaho pear was found to have been infested. Of ten trees of this variety planted by Mr. Cohee four of them had died from the effect of the scale, and others were badly infested. The scale was introduced on the Idaho pear from the nursery.

In a letter dated November 22nd Mr. Cohee says: "In reply to your letter of the 17th instant, will say that I still have a few scale upon my trees. February last I cut the trees within a foot and a-half of the ground, and gave the remaining stumps a scrubbing with soft soap and carbolic acid. They have made from three to five feet growth this season. Upon close examination recently I found the scale still present in small numbers upon three out of five trees. I have been to see Mr. Russell and Mr. Mitchell, and find their trees still infested with the pest, but I cannot see that it has spread. One of the parties dug up the infested Idaho pear trees and planted other trees in the same place, and I find they now have a few scales upon them."

Federalsburg:—March 6th, 1897, Mr. John Manning, of Federalsburg, sent me twigs cut from Abundance and Satsuma plum in his orchard, that were literally covered with the scale. The orchard contains about one hundred trees, principally plum and apple, planted three and four years ago. Many of the trees died prematurely, and the weak, unhealthy condition of the others attracted attention of the owner. Under date of March 10th I made reply, and gave due warning as to the deadly nature of this pest, and urged the necessity of prompt action for its check and control.

Mr. Manning writes me November 23rd, as follows: "I am in receipt of yours of the 17th instant, and I am sorry to say that I still have some of the San Jose scale. One apple tree purchased in the spring of 1895 is very badly infested. The tree came from the same nursery as the original stock, samples of which I sent you last spring. I burned those trees on the spot they grew, and I intend to try to get rid of the pest this winter."

Preston:—Mr. A. H. Larimore, of Easton, reported to me April 17th, 1897, that he had found a bad case of the San Jose scale on Japan plums on the place of Mr. Willett Harris, of Preston, and that some of the trees were dead. The scale had also spread to other trees in the vicinity. Upon the receipt of this communication I wrote to Mr. Harris April 22d, asking for twigs from the infested trees for examination, but have had no reply up to the present time, March 14th.

CARROLL.

Westminster:—September 9th, 1896, I discovered this pest on a tree on the premises of the Rev. S. A. Diehl. As I was passing the place my attention was first attracted to a peach tree, one-half of which was apparently dead, and upon close examination, I found it completely encrusted with the scale. Fortunately for the owner, not more than fifteen trees were involved, all of which were planted in his garden and yard. My letter of the 30th instant to Mr. Diehl explains the attack somewhat in detail, and I quote part of it herewith:

"On the 9th instant I discovered the dreaded San Jose scale on peach trees growing in your yard in the rear of your residence. It is not necessary for me to say that this pest threatens the destruction of our fruit industry, unless it is speedily checked.

Many bulletins have been published regarding it, and, no doubt, its natural history is familiar to you. It is to be regretted that this, the worst of all orchard pests, has established itself in your county. Heretofore it was not known to occur in Carroll County, and we will leave nothing undone to suppress it and check its further spread in your vicinity. The importance of the attack on your place is intensified from the fact that there is an extensive nursery near by.

"A careful examination of all the trees on your place shows that the scale has found lodgment on them. I was sorry you were not at home while I was there, but I fully explained the whole matter to your wife, and I presume you understand the interests at stake, and have acted accordingly. If you have not destroyed the peach trees next to the fence near the lane, I would advise you to have them dug up and burned at once. There is a small apple tree near the peach tree nearest the house badly infested. This also should come out; in fact, I would suggest that all the badly infested trees on the place be destroyed. The trees in the chicken yard are very badly infested with both the San Jose scale and the scurfy bark louse. There is a pear tree in the corner of the lot near the chicken yard that is in very bad condition. The currant bushes in this corner are almost literally covered with the scale.

"The old peach tree along the walk near the house, and which has been cut back, is badly attacked with that dangerous disease known as Yellows. No time should be spared in the destruction of this tree, root and branch.

"As I suggested to your wife, some of the trees can, no doubt, be saved, but it will necessitate a vigorous pruning and a thorough application of whale oil soap. This soap can be bought at from three to five cents per pound, and should be applied in the autumn as soon as the leaves fall, at the rate of two pounds to a gallon of water. It should be put on hot, and with a good spray pump. This treatment should be repeated in the spring just before the blossoms appear.

"We can hope to keep this pest in check only by the most energetic and persistent fighting. I am very anxious to know from what source the peach trees came, especially those near the lane, as they seem to indicate that the pest was upon them when planted. Any information you can give me will be greatly appreciated. If I can be of any future service to you in your warfare against this pest please command me."

In reply to the above I received the following letter from Mr. Diehl November 23d: "Your letter dated September 30th, was received October 1st. Before having received your letter of instruction, in fact, the morning after you were here, I took up and burned the two peach trees near the lane in the garden and also the little apple tree and pear tree in the garden near the fence of the chicken yard. The other trees I thought might be saved by proper treatment.

"Now, first, as to the origin of the pest; that you did not see. It was an apple tree presented to me by Mr. Edwin Lawyier, a neighbor, last spring, three years ago. It soon showed the scales, the nature of which I did not fully understand. I gave it a good scrubbing with wood ash lye, which cleaned it up for the time being, but a year later it was almost as bad as before, and did not grow. I then dug it up and burned it. Mr. Lawyier told me that it came from Mr. Parry's nursery in New Jersey, if memory serves me right. Then Mr. Stoner gave me the apple tree which had also taken the disease as a natural consequence. The peach nearest the house, along the lane, I bought from the Peters nursery, Adams County, Pa. It was a clean tree, I have reason to believe, when I received it, and got the scale from the apple tree which stood near by. The large peach tree on which you first discovered the scale grew there from seed within four years, and got the bugs from either the apple or other peach tree. The large tree which was cut back, and which you say had the yellows, I also destroyed. Last week the leaves were about all off of the other trees, so I gave them a heroic, or as you say, vigorous trimming back, then prepared the whale oil soap solution, and with a paint brush carefully painted trunk, every branch, and what twigs were left, so that they looked as though they were whitewashed. I also thoroughly coated the currant bushes. Mr. Stoner says he will get a spray pump and spray the trees for me next spring. I shall hereafter keep a sharp lookout for the indication of the presence of this nasty pest. The other peach tree in the garden, where the large diseased one stood next to the walk, remained healthy in appearance, and yielded most excellent fruit, a large, yellow, sweet peach. Mr. Stoner pronounced it Smock. The storm broke about one-third of it down which I removed, and now have done all that I can do to save the remaining part of the tree from the scale. Since the rain washed some of the soap off the trees they look nice and clean. Thanking you for your definite and very satisfactory instruction, I remain, sincerely yours, in the warfare against the Devil and also against the San Jose scale bugs."

I made another examination of the trees remaining on Mr. Diehl's place September 8, 1897, and again on October 3d. I found a plum and three peach trees still attacked by the scale, even after the heroic treatment that had been given them. The plum, although a small tree, was thickly covered with scales, and has since been destroyed; while the peach trees will be sprayed again this fall.

The pest has also spread from here to trees on several adjoining premises. In the garden of Mr. J. Shafer I found it thickly covering a peach tree about four years old, and a plum tree two years old. There were also several peach seedling that had come up voluntarily in the garden, and these were found infested. Several large apple trees and a grape vine in the same garden contained the scale. I advised Mr. Shafer to destroy the badly infested trees in a letter dated September 9th. At the time of my visit, October 3d, I found the peach tree had been destroyed, and several large limbs on the infested apple trees had been cut off; but the infested plum tree, peach seedling and grape vine still remained. After some little urging Mr. Shafer was induced to destroy all the infested plants.

The scale was also found on apple on the premises of Mr. John Zengraft, and on apple, pear and peach trees in the garden of Mrs. G. Snowden. Both parties were given due notice of the presence of the dangerous pest, and advised to spray the infested trees with whale oil soap. At still another place I found several hundred two-year--old Ben Davis apple trees infested, all of which were uprooted and burned.

CHARLES.

Riverside:—The specific determination of the scale at this place was made in March, 1894, by Dr. L. O. Howard, the United States Entomologist at Washington. Mr. C. L. Marlatt, an assistant, was at once detailed to examine the orchard, which is situated on the river front, and is owned by Mr. Elymet Dows. It covers an area of about twenty acres, consisting of about two thousand peach and several hundred apple trees. The trees were purchased in the fall of 1887 and planted the spring of 1888. At the time of Mr. Marlatt's visit many of them had died from the attacks of the scale, and had been destroyed. The pest, however, had spread to other parts of the orchard. On account of the nearness of this infested orchard to Washington, it was used by the Division of Entomology of the Department of Agriculture for experimental purposes.

In response to a recent letter in regard to the present condition of the orchard, Mr. Dows writes under date of November 29th, as follows: "Yours of the 17th instant received, in which you request an account of the present condition of my orchard, to what extent it has been infested, from what source the outbreak occurred, and my opinion of the San Jose scale as a destructive orchard pest.

"The insect was brought to my place from the nursery, and this occurring before the pest was known in the East placed me at a great disadvantage. For two or three years I saw something was wrong (many trees dying), and tried various remedies, but found my orchard going from bad to worse. I then took samples to the Agricultural Department, Washington, D. C., where Professor Howard at once became interested in the subject, and with the assistance of Messrs. Marlatt and Coquillett made numerous experiments and many examinations (see Bulletin No. 3 by Professors Howard and Marlatt), and on finding whale oil soap the most effective remedy, advised its use, since which I have used it every spring on my trees, and feel certain I have the pest under control, and the living trees are at present in a fairly healthy condition.

"In looking at the matter from a business and a paying standpoint, my experience is that small trees may probably be successfully dealt with, but large, badly infested trees can not. In my case the cost so far has been $5 for every cent of income, and I should not have fought so persistently but for my constitutional objection to defeat.

"In regard to the spreading of the insect from my place to that of the persons you mention I am unable to say, not having studied that part of the subject; but if the nursery from which their stock was received was clear, and I have heard nothing to the contrary, should consider Professor Howard's idea the right one."

At the time of Mr. Marlatt's first visit, so far as could be determined, the orchards in the neighborhood were free from the insect. In October, 1895, however, he found that two young peach orchards belonging to Mr. Robert Marbury and Mr. W. D. Swan, about a mile south of Mr. Dow's place, were slightly infested, and the general conclusion was that the pest had been carried there by birds or insects from the orchard of Mr. Dow.

July 23, 1896, the writer accompanied Messrs. Marlatt and Schwarz, both assistants of the Division of Entomology, Department of Agriculture, to Riverside, where they had been detailed to examine and report upon the condition of a colony of predaceous insects, *Scymnus marginicollis*, which had been imported from California and liberated at that place.* The orchard of Mr. Marbury was carefully searched for the little ladybug, but not a single specimen was procured. The grass and weeds were swept with a net in the vicinity of the trees where the insects had been liberated, but not one was discovered. The orchard was in very bad condition, having been neglected somewhat on account of its unhealthy condition. About five hundred trees were found literally covered with the scale in all stages of development. The young were crawling in great numbers, and in one instance a small black ant (*Monomorium minutum*) was seen carrying a partially matured female in its jaws. Adults and larvae of a little blackish ladybug (*Pentilia misella*) were also observed running around over the infested trees, but none were seen feeding upon the scale. The orchard contained about one thousand trees, many of which were badly injured by the peach tree borer, while others were dying from the attacks of Yellows. In all, the orchard presented a very pitiful sight.

Many trees in an adjoining orchard belonging to Mr. Swan had also died from the attacks of the scale, and leafless trees, dry and hard, were dotted here and there throughout the orchard. The present condition of the orchard is given in the following letter received from Mr. Marbury November 22d, 1897. He says: "Replying to your inquiry of November 17th, will say that my orchard originally contained 1,000 trees. I estimate that 750 are now dead or dying, and the grubbing hoe will finish the rest. The peach crop I consider the poorest we can undertake to raise in Southern Maryland counties. I knew nothing of the nature of the insect, and gave up in disgust, when I found the orchard was attacked by it.

Nanjemoy:—While in Annapolis, February 9th, I learned that the orchard of Dr. S. H. Speake, of this place, has been infested with this scale for some time. In reply to my letter of inquiry, February 11th, Dr. Speake says under date of February 17th, that his orchard has been infested with San Jose scale, and that nearly all of his trees have been killed. The trees originally came from a Virginia nursery, and without doubt the scale was introduced with them, as he says "the trees in another part of the farm, coming from a different place, did not have the scale."

I wrote again for specimen twigs for examination, which were duly received and found infested with the genuine San Jose scale. Dr. Speake wrote me March 4th, as follows: "I mailed you a few days ago some twigs, cut from my peach orchard of 1,200 trees. The branches of the trees are nearly all killed by the San Jose scale, but new growth is starting from the body of the tree. It first commenced in two rows of trees. I think Heath Cling, and spread slowly over the orchard. I intend when I cultivate the land again, to cut down or grub out all the trees in the orchard."

Mason Springs:—The infestation at this point was upon nursery stock from New Jersey, purchased the spring and fall of 1896. I visited

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*An attempt was made to introduce *Rhizobius debilis* (*lophantrae*,) but the insect proved to be *Sycmnus marginicollis*.

the place of Mr. F. T. Maddox, March 15th, 1897, and made an examination of his orchard. I found the scale clustered upon one Lawrence pear, which had been planted the fall previous, consequently the scale had not spread to other trees. It was uprooted and burned. The pest was not found upon any other trees on this place.

In a young orchard of Mr. H. Turner Rowe, a near neighbor, I also found the scale thickly encrusted upon a Lawson pear that had been planted in April, 1896. Another tree, a Lawrence pear, planted in November, 1896, from the same nursery, was also infested, showing without a doubt that the tree was infested when it was planted. Mr. Rowe was instructed to dig up and burn the infested trees.

Still another infested orchard in this locality, the trees having come from the same source as the above, four and five years ago, came to my attention March 26th, 1897, at which time Mr. G. E. Medley sent me twigs cut from his Bartlett pears for examination. In a letter March 29th, I advised the destruction of the badly infested trees and the spraying of all suspicious ones with whale oil soap. All the young trees in the orchards of Messrs. Maddox and Rowe were also sprayed with whale oil soap, as advised, and we believe we have checked the spread of this pest in this locality.

In a letter dated November 19th, 1897, Mr. Maddox says: "In reply to yours of the 17th instant, regarding the San Jose scale, would say that Mr. Rowe, Mr. Medley and myself think the soap you sent us entirely eradicated and destroyed it, as we fail to find any symptoms of the scale on our trees now, after carefully watching them. I used the soap three or four times on mine with paint brush. They have made wonderful growth and look very healthy."

CECIL.

Perryville:—While in the upper part of Cecil County, September 17th, 1897, I learned incidentally that Mr. George W. Sutton, of Perryville, was of the opinion that he had the San Jose scale in his young Duchess pear orchard. I called upon him the same day and made an inspection of the trees and found four of them dead from the attacks of this pest. The scale had spread to all the other trees, and they were in such a serious condition I advised their immediate destruction. There were only twenty-five trees in the lot, purchased and set out one year ago last spring. Fortunately there were no old trees in the immediate vicinity, and the introduction of the scale at this point was made upon the trees from the nursery, and from present indications has been destroyed at this place.

DORCHESTER.

Linkwood:—The outbreak at this place is in the orchard of Mr. Robert L. Gulick. The pest seems to have been introduced upon nursery stock purchased the spring and fall of 1888, but its presence was not definitely determined until January, 1895. At that time, Mr. Gulick took specimen twigs to the meeting of the Peninsular Horticultural Society, and the pest was identified by Mr. Marlatt. The orchard contains many varieties, and was inspected by me March 30th, 1897. I found it in very bad condition. Many trees had been cut back to the trunk and the scale was very generally distributed. I observed it here upon the largest number of varieties of any place in the state, including peach, pear, apple, plum and quince. Many of the trees are dwarfed and stunted, having made little or no growth.

Mr. Gulick has fought the pest persistently since 1895, but has not succeeded in exterminating it. He has used large quantities of potash lye in water, at the rate of one pound of lye to two and three gallons of water, washing the trees by hand. I found many living scales upon trees washed with the weaker solution, but where the stronger solution was used, a very small percentage of living insects remained.

I made a second inspection of this orchard August 26th, and did not find nearly as many live scales. The whole orchard has been treated with lye and water at the rate of one pound to two gallons. Only an occasional scale could be found upon trees that were literally covered in the spring. Many insects had been destroyed, evidently by some predaceous enemy, as the scales had been ruptured. I saw no insect responsible for the work.

In reply to a letter of inquiry, regarding the number of varieties in his orchard that were infested, Mr. Gulick wrote me January 24th, as follows: "The following is the list of varieties of trees infested with the San Jose scale: *Peach:* Old Mixon, Mystery and Early Rivers; *Quince*: Fuller's Orange, Meeches, Alaska and Champion. *Pears*: Big Seckel, Duchess, Anjou, Lawrence, Louise Bonnie and Mt. Vernon. *Plums*: Ogon, Botan, Maru, Kelsey, Abundance, Yosebe, Silver Prune, Spalding, Tour Sweet Botan, Burbank, Satsuma, Botankio, Hattankio, Chabot, Lombard, Free Stone Dawson, Roulette, Newman, Williard, and Whitaker. *Apples*: Nyack Pippin, Fourth of July, Early Ripe, Stayman's Winesap, Yellow Bellflower, Gano, Ben Davis, McCullough, Rome Beauty, Lawyer, McNash, Talmon Sweet, Arkansas Black, American Blush, Red Cider, Winter Banana, Grimes Golden, Springdale, Vandevere, Black Twig, Newtown Pippin, Carthouse, Wine Sap, Nashville, Mammoth, Robinette, Spitzenburg, Baldwin, Salome, Nansemond, Beauty and Florence Crab. The list of plums is not quite complete. The total number of trees in the infested orchard is 750. I think the spread of the insect is very slow where there are few on a tree. When they become numerous, they find means of getting to favorite varieties of trees. A small number of insects will stunt the growth of small trees, and the most impoverished condition of infested trees is in November and December."

There are thirty-one infested varieties of apple in the above list, twenty of plum, six pear, five quince and three peach, making a total of sixty-three different varieties in all.

Cornersville:—The infested orchards at this place belong to Mr. Thomas R. Hubbard and Mr. D. L. Moore. My attention was first called to the condition of the trees by Mr. A. H. Larrimore, of Easton, who noticed their depleted condition. He wrote me September 4th, 1897, stating that he believed the orchard was infested by the San Jose scale. Upon receipt of this information I wrote Mr. Hubbard September 9th to send me sample twigs from the diseased trees. He complied with my request September 27th, and I found the twigs badly attacked by the deadly enemy. After some further correspondence I have ascertained the following facts:

Mr. Moore writes November 29th, as follows: "Yours of the 27th received and contents noted. Will say in regard to your inquiry that some of my trees are affected with the San Jose scale. I have only about two dozen trees, and I think about half of them are more or less affected. Those which are effected most were purchased about eight years ago.

In reply to my letter of inquiry, Mr. Hubbard writes me the following December 11th: "My orchard consists of the following named trees, viz: 100 apple, 30 plum, 50 peach, 75 pear and 13 quince, 273 in all, and I do not believe there are a dozen trees but what are infested with the scale.

"This orchard was planted in November, 1891. I noticed in planting that two of the apple trees had some patches of a dark gray substance on them that could be scratched up with the finger nail. I did not know what it was, not being familiar with the scale; in fact, had not heard of it being in Maryland; but in the summer of 1893 I noticed these trees failing, and upon examination I found them completely covered with the scale. My opinion is that the pest was brought from the nursery. I am thinking of topping all my trees this winter and covering them with soft soap. What do you think of the idea?"

I advised Mr. Hubbard to use whale oil instead of soft soap. The latter has been used to good advantage in many instances, but the former is very much more satisfactory.

Cambridge:—January 22nd, 1898, Mr. W. G. Dawson wrote me from Cambridge that Mr. Thomas P. Peters, near that place, had an orchard which was infested with the San Jose scale, and that he intended to cut down and burn all the infested trees. Upon receipt of this information I wrote Mr. Peters January 25th, asking for more detailed information regarding his orchard, and received the following reply February 25th: "I herewith enclose specimen twigs of last year's growth cut from my peach orchard for your examination. I am not positive what the difficulty is, but from what information I gained at the Farmers' Institute in Cambridge, I pronounce it the San Jose scale. About one-half of my trees are dead, and most of the others infested. I do not know of any other orchard similarly affected in this vicinity, but think they must be, as I have heard people complaining of their trees dying rapidly. Please let me know when you expect to be in this county, as I would like to be at home at the time of your coming."

The twigs Mr. Peters sent me were badly infested with the San Jose scale, but fully 95 per cent. of them were dead when received. The scales were rather whitish and collapsed. I could not ascertain the cause, as it certainly was not due to parasites or predaceous insects, and no indications of fungus disease. In reply to my later inquiry, Mr. Peters wrote March 4th, as follows: "I am in receipt of yours of the 1st instant, and in reply will say, that it is very discouraging to know that I have such a destructive pest with which to contend. The trees, 225 peach, 12 pear, 12 plum and 6 quince, were purchased from a New York firm, and the scale first appeared upon them. I also had about 725 other trees which seemed perfectly healthy until lately. I do not think the scale has any choice as to variety of peach, and that tree seems to be the ideal breeding place. Fully three-fourths of my peach trees are infested. At this writing I am not prepared to say whether there is any scale on the plum, pear or apple."

Ellwood:—The infestation at this point is in the orchard of V. S. Vickers. April 21st, 1898, I received information of such a nature that I felt quite sure that the insect had gained a foothold in this orchard, and in reply to my inquiry of April 23rd, Mr. Vickers sent me twigs cut from the orchard, and I found them very badly infested with the scale. The orchard was set out about three years ago. I wrote another letter of inquiry on the 30th, asking other questions regarding the trees and the general conditions of the surrounding orchards.

FREDERICK.

Frederick City:—The infestation at this place is supposed to have come on plum trees purchased in April, 1893. Mr. D. W. Coquillett, of the United States Department of Agriculture, inspected the trees December 27th, 1894, and found the scale still present upon some of the original stock. Mr. Coquillett made a second examination some time later, and was unable to find any further indications of the scale, the stock originally attacked having been destroyed.

I made a careful examination of the trees on this and other places in the vicinity September 10th, 1896, and found a very bad state of affairs. The scale was found upon cherry, apple, peach, pear, plum and quince. Some of the trees were literally covered with the pest, and a two-year-old cherry tree (Napoleon Bigarreau) had been killed. There is no question but what the scale was introduced upon stock from the nursery. An examination of trees in the gardens of several persons living in the vicinity revealed the fact that the pest has spread to a considerable extent.

Several peach trees in a lot belonging to Mr. Frederick Kintz were very badly infested. It was found also on plum trees in the yard of Mr. E. M. Dyer, and upon peach in the gardens of Messrs. P. R. Renner, D. S. Rice and L. F. Kussmaul. It was also noticed upon a small peach tree in the yard of Mrs. John Holmes. A bulletin (No. 42, Maryland Experiment Station) containing information about this insect was sent to each of the above named individuals, and attention called to the presence of this dangerous pest upon their premises.

At the time of my visit, September 28th, 1896, I found all the infested trees on the premises where the pest was originally introduced had been destroyed; but several infested peach trees on adjoining lots were still standing. The attention of the owner was again called to the necessity of immediate action for their destruction.

I made another inspection of these places September 3rd and 4th, 1897, and found that the scale was still present. Two peach trees on the lot belonging to Mr. Dyer were literally covered. These trees were also infested with the terrapin scale (*Lecanium-negro-fasciatus*). I advised Mr. Dyer in a letter September 9th that it would be

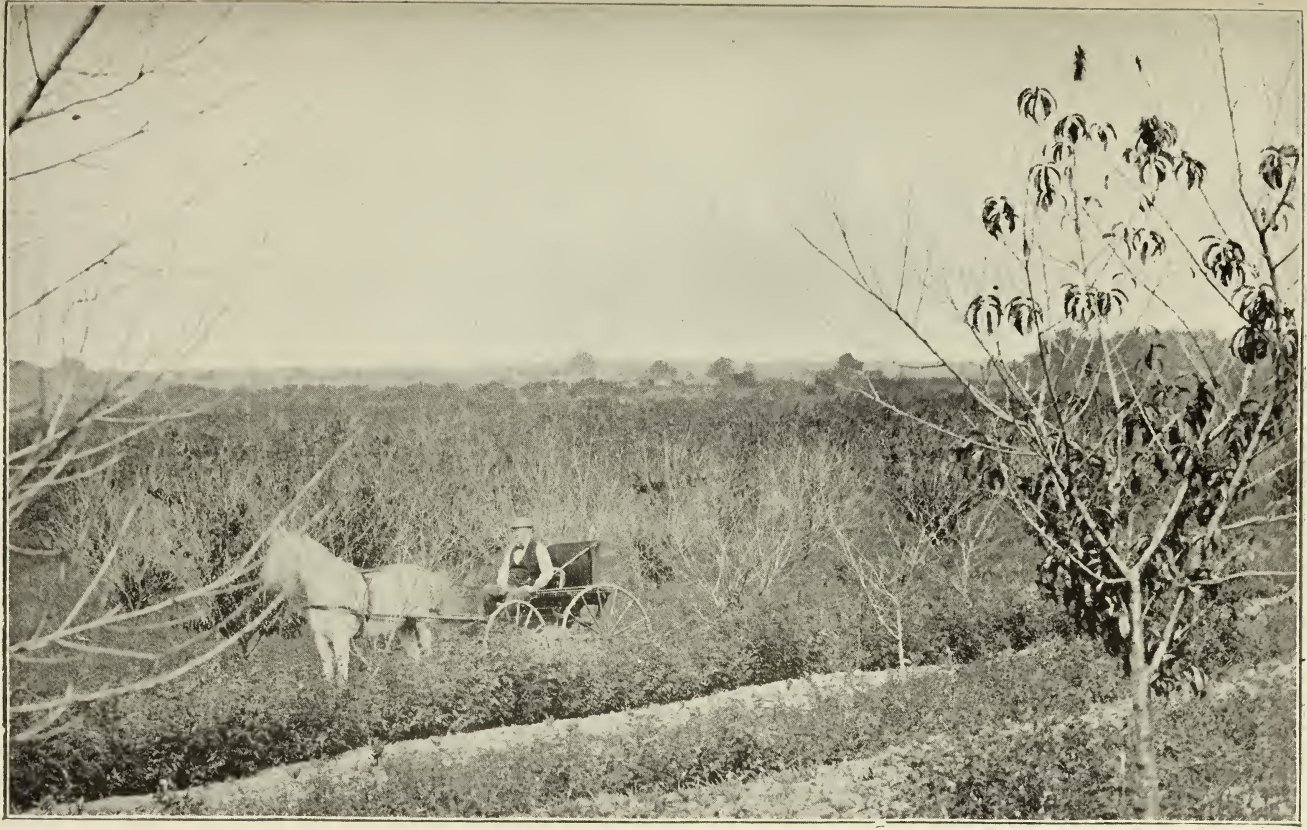

Figure 4.—Scene in a 300 acre peach orchard destroyed by the San Jose scale. Very few trees with any signs of life. From a photograph taken August 6, 1897, by W. G. Johnson.

good policy for him to destroy the trees, not only for his own protection, but also that of his neighbors. The scale was also present in small numbers upon an old peach tree in an adjoining lot. Several apple trees on the farm of Mr. Hock, a few miles north of Frederick, were found infested, all of which were uprooted and burned. There is some doubt as to the source of the infestation at this point.

My attention was called to another infested orchard in the vicinity of Frederick March 8th, 1897. The owner, Mr. Samuel T. Hargett, wrote Mr. W. L. Amoss, Director of the Department of Farmers' Institutes, who referred the matter to me. The orchard contains about four hundred trees, from five to seven years old. Speaking of the trees, Mr. Hargett says: "Among them I discovered three only which I considered diseased. Symptoms of the disease, rough, scaly bark, with body and branches like sample enclosed. If convenient, please let me know what is best to do with them?"

I immediately wrote Mr. Hargett, stating that the insect responsible for the injury to his trees was the San Jose scale, and advised him to take immediate steps for its control. He replied March 10th that he would begin spraying with whale oil soap, as suggested, and endeavor to check its further spread.

In a letter to me, dated November 30, 1897, Mr. Hargett says: "The infested trees were sprayed with whale oil soap as directed. I gave them two applications, and I believe I have the scale under control."

While in Frederick I also learned of the presence of the scale upon some trees on the premises of Mr. J. W. Keller. I made an examination of the place, and found the pest upon a few peach trees in the yard. The insect seems to have been introduced about two years ago upon pear trees which have since died and have been removed.

Another infestation near Frederick was brought to my attention by Mr. H. B. Witter January 25th, 1897. The trees belong to Mr. G. M. Hedges, and were planted in his yard and garden near his house four and five years ago. Mr. Hedges was aware of the fact that the trees were not healthy; but not until January 16th did he know what caused the trouble, at which time he received a letter from Dr. L. O. Howard, the United States Entomologist, in reply to his query of January 11th.

I made an examination of the premises September 5th, 1897, and found that Mr. Hedges had dug up and destroyed several pear trees which had been badly infested. There were several pear and apple trees still standing, all of which had been attacked. They had been pruned and washed with a double dose of whale oil soap. There were still a few living scales upon them, but the trees were in such miserable condition I suggested it would be economy to uproot and burn them. The scale had also gotten on an osage orange hedge fence near by, and Mr. Hedges had burned it on both sides for a distance of several rods.

March 21st, 1898, I received a number of twigs cut from a plum tree in a small orchard of about 80 trees, belonging to Mr. D. C. Winebrenner, of this place, asking information regarding the disease which he found upon them. On examination I found that they were pretty badly infested with the San Jose scale, and upon making further inquiry, I found the trees were planted in the spring of 1895. Directions were given for the immediate destruction of the badly infested trees and treatment for the others.

Araby:—While in Frederick September 5th, 1897, I heard that an orchard in the vicinity of Frederick Junction was dying out from some mysterious cause. I drove to the place, and found Col. Carroll Mercer. the present owner, but he could give me little or no information about the orchard, as he had just recently purchased the property. The orchard is beautifully located on the side of a hill, and contains about twenty-five hundred trees. Several hundred trees in the western end of the orchard were dead or dying from the attacks of the San Jose scale. Many trees have been dead for several years, and it was not difficult to locate the trees which bore the original infestation. The pest had spread over about two-thirds of the orchard, many of the trees still living, but literally encrusted.

I called upon Mr. J. H. Gambrill, the former owner of the place, and he informed me that the trees were planted in the fall of 1891 and spring of 1892. He said that there was little or no doubt in his mind that the pest, since it had been called to his attention, had been introduced upon the stock from the nursery. He stated that he had noticed the trees were unhealthy in this particular section of the orchard from the time they were first planted, and that he had paid especial attention to this section, worming, fertilizing and plowing, as he supposed the difficulty was due to some soil conditions.

Several hundred of the trees in the badly infested portion of the orchard made a beautiful growth for the first three or four years, and were then gradually killed out, dying from the tops downward. On many trees a vigorous new growth had sprung up from the trunk, which gave them a very peculiar appearance. The leaves on this second growth were unusually large, some of them measuring nine inches in length and from two to two and a-half inches in width. This dense green foliage growing from around the base of the trees was very striking as it stood out in contrast with the dead and leafless branches.

I made a second examination of this place October 9th, and in company with Colonel Mercer went over the orchard quite thoroughly. He was much surprised to find the pest so widely distributed, and was much interested in the attack, as it was the first he had ever seen. At the time of this visit I found that Colonel Mercer had been worming and working around the base of the infested trees, hoping that he might, by this treatment, restore them to their former vitality. I assured him that he was simply wasting time, as the deadly nature of the insect would soon sap the life from the tree in spite of all the worming and fertilizing he might do. I also assured him that there was but one remedy for trees where they were as badly infested as those in the greater part of his orchard, and that was their immediate destruction, especially those trees which were so literally covered that little or no life remained. I told him there was a possibility that he might save part of the orchard by spraying persistently year after year, but conditions were against him, and it was doubtful whether it would pay him to do it.

Burkittsville:—The outbreak at this place was called to my attention by the owner of the orchard, Mr. H. W. Shafer, who wrote me, as follows, December 14th, 1896: "You will find enclosed cuttings from a few apple trees. Can you tell me what is the matter with them? The orchard is about six years old, and some of the trees are apparently dying from this scab. Please advise me what to do for them."

Upon receipt of this letter, together with the infested twigs, I wrote Mr. Shafer December 19th, stating that his trees were infested with the San Jose scale, and gave him the necessary information for the treatment of the orchard.

In a letter dated December 28th, Mr. Shafer states that the trees were apparently vigorous until the summer of 1895. Up to that time he says, he never saw trees grow faster or look better. In all, about one-half of an orchard of one hundred trees is infested with this pest. No other orchard in the vicinity is known to contain this scale, and there seems to be little or no doubt but that it was introduced upon the nursery stock at the time it was purchased, as it came from a nursery that is known to have been infested for several years past.

GARRETT.

Mountain Lake Park:—I discovered this insect at this place in a block of one hundred plum trees September 7th, 1896. Only two of the trees were found badly infested, and from general appearances the scale had not been able to hold its own at this altitude, Oakland (2,391 feet). These trees came originally from a nursery in one of the Northern States, and so far as a careful examination went, the scale had not spread to a block of five hundred apple trees, two hundred pear trees and one hundred cherry trees in the immediate vicinity. The infested trees were uprooted and destroyed immediately.

These trees were again examined by me October 5th, 1897, but no further traces of the scale could be found, and I am of the opinion that it has been entirely exterminated at this point, probably due, as stated above, to the high altitude, and other conditions which exist in this mountain district.

HARFORD.

Jerusalem Mills:—The following letter from Mr. Harold Walsh, dated October 27th, 1896, explains the nature of the outbreak at this place: He says: "I enclose herewith section of a twig taken from a Japan Golden Russet pear growing on an adjoining farm. I think it is infested with the San Jose scale. Am I correct? The tree is three years old, and the trunk is entirely covered with this scale. Kindly let me hear from you?"

Immediately upon receipt of this, I wrote Mr. Walsh, under date of October 29th, as follows: "Yours of the 27th instant, with enclosure is at hand, and in reply would say that you are correct in your identification of the San Jose scale. The twig you send is badly infested with this insect. I would like to have further information regarding this outbreak, and will be greatly obliged to you if you will ascertain, if possible, how many trees are in the immediate vicinity of the infested one from which the sample was taken. Judging from the looks of the specimen before me, I am of the opinion that the pest has spread to a considerable distance in your neighborhood."

In reply to the above, I received the following letter, dated November 17th, from Mr. Walsh: "Please pardon the delay in answering your favor of October 29th. The tree from which specimen of the San Jose scale was taken stood in the center of a block of twenty-eight pear trees. The owner has made a careful inspection of the remaining trees with glass, but found no San Jose scale. He tells me that there are other scales present, such as are often seen upon trees. All the trees in question were planted the spring of 1895."

From other information which I have in hand, there is no doubt but what the scale was introduced at the time the trees were purchased from the nursery. This conclusion is further substantiated by the fact that the nursery from which they were purchased is known to have been badly infested with this pest for several years past.

The present condition of this orchard is told by Mr. Walsh in a recent communication, dated December 1st, which is as follows: "In reply to your favor of November 23rd, I am glad to be able to say that the orchard you refer to is entirely free of the San Jose scale. There was, I think, but one tree infested with the scale, and that was dug up, root and branch, and destroyed by burning. The above was the only outbreak of the San Jose scale in this neighborhood of which I am aware."

Pylesville:—The infested trees at this place were discovered by the owner, Mr. E. A. Wilson, who sent specimen pear twigs to Professor Robinson, who referred them to me. I found them very badly attacked by the San Jose scale, and immediately notified the owner, and asked for more definite information. In reply I received the following letter, February 18th: "Yours of the 17th instant at hand, and I am very sorry to note that I have the San Jose scale in my orchard. I suppose the sooner I begin fighting it the better. It was pronounced the oyster shell scale by a nurseryman who was at my place some time ago. I have about sixty trees, and they were bought about four or five years ago from a Pennsylvania nurseryman." My second letter was dated the 19th, and I advised the destruction of all the badly infested trees, and the spraying of the others as soon as possible with whale oil oap.

HOWARD.

Annapolis Junction:—The outbreak here is in the extensive orchards of Col. W. S. Powell, and was first called to my attention October 30th, 1897, by Mr. M. B. Waite, Assistant Pathologist of the United States Department of Agriculture, who had noticed the insects upon some plum trees in the orchard October 9th, at which time he addressed the Vansville Farmers' Club, which met at Col. Powell's residence.

I visited this place November 6th, and made a careful examination of the trees. Col. Powell informs me that this orchard was planted in the fall of 1893, and contains fifty Abundance plums, fifty Botankio plums, one hundred and ninety York Imperial apples, ten Early Ripe apples, two hundred and fifty Kieffer pears, two hundred and fifty Bartlett pears and four hundred Champion quinces.

Currants, gooseberries and asparagus have been planted between the rows in the lower part of the pear orchard. This attack is explained in full in my letter of November 8th to Colonel Powell, which is as follows: "As a result of the examination of your orchard Saturday last, I am obliged to inform you that I found the San Jose scale thickly colonized upon half a dozen plum trees, and has spread from these to all the other plums in the same block. I did not have time to examine every individual tree, but found it wherever the inspection was made in the plum orchard. I found it also on pear well down the hill, showing beyond all doubt that it has spread to a considerable extent. It is also upon a few quince trees in the immediate vicinity of the plum. I did not see it upon apple, but feel sure it has found lodgment there, especially on the side between the plum orchard and your house.

"The scale seems to have originated upon a few plum trees. I believe we can check the spread of this pest in your orchard, and it will be a pleasure for me to undertake this task, if you will permit me to superintend the work, the only condition being that the necessary labor and a few chemicals be furnished by you."

The next day I received the following letter from Col. Powell, which explains itself: "I am in receipt of your letter of November 8th, and thank you for same. I had regularly examined the orchard up to about June 1st last, and then, to my eye, there was no scale, but on last Sunday, after your visit, I went through the orchard, and was horrified to find its extent in the plums. Of course, I accept your proposition for the experiments you wish to make in this orchard, and really, owing to its central location, and all being young trees, I should think it would be a valuable object lesson, not only for the members of the Vansville Farmers' Club, but to all nearby farmers who have been watching the orchard's growth with considerable interest. Just have your whole outfit consigned to me, let me know what chemicals you need and what assistance you will want, and I will promptly make the arrangements."

Dayton:—April 11th, 1898, I received a letter from Mr. W. F. Bergman, of this place, enclosing specimen twigs cut from an apple tree for examination. Upon one of them I found a cluster of eggs of the katydid, and the other was thoroughly infested with the scurfy scale. Mr. Bergman intimated in this letter that he had several plum trees which were infested with a scale similar to the one on apple. Although I did not question the accuracy of Mr. Bergman's determination, I felt in justice to him that it would be better for me to have specimen twigs from the plum trees in order that I might examine them and make sure the insect was the same as that found on the apple. As a rule, it is not easy for the average observer to distinguish the different species of scale insects. I had a suspicion that the insect upon the plum was possibly the San Jose scale, and upon receipt of the twigs, which arrived April 18th, I found that my suspicion was well founded, as the twigs were very badly infested with that insect. I immediately wrote the gentleman the result of my determination, and advised him what to do.

KENT.

Chestertown:—The occurrence of the scale at this place is in the orchards of Robert S. Emory, one of the largest (if not the largest) and most succesful pear grower in Maryland. Captain Emory was aware of the presence of the insect in his orchard for several years, but did not ascertain definitely what it was until July, 1894, at which time he brought it to the attention of Mr. C. L. Marlatt, of the United States Department of Agriculture, who was at his place making some studies upon the Psylla, another insect which is very injurious to pear.

The scale was introduced into this orchard upon two hundred and fifty Lawson pear trees, purchased October 26th, 1888, of Parry Bros., Parry, New Jersey. At the time the trees were received Captain Emory noticed that they were not as clean and healthy looking as other trees which he had purchased from other sources. The trees were planted, however, under complaint as to their inferiority. They did not make the usual normal growth, and Captain Emory was of the opinion that they were infested with some contagious disease; but was not aware of the nature of the disease until later, as noted above. He became alarmed in 1892, noticing that the disease, whatever it was, had spread to other blocks of trees in the same neighborhood, and began an extensive series of experiments, unaided, for the suppression of the mysterious disorder. Thinking it a species of scale insect, and having a supply of whale oil soap on hand, which he had been using against the pear leaf slug, he applied this material as a winter wash to every suspected tree. He coated the trunks and larger branches with soap which he had diluted with water to a consistency of thick soft soap.

In August, 1894, the pear Psylla, an insect very injurious to pear trees, was doing much damage in Capt. Emory's orchard, and he called on Dr. Howard for assistance, who detailed Mr. Marlatt to make an investigation of the outbreak. It was at this time that Mr. Marlatt's attention was called to the scale, and after treating many trees for the Psylla he began some experimental tests upon the scale. While Mr. Marlatt was engaged at this work Captain Emory called his attention to the whale oil soap treatment of 1892, and prepared some of the material to show him. One of the trees that had been badly infested, and originally treated with the soap, and which still bore a few scales, was again treated in October. The tree was healthy and had made a beautiful growth, although it still retained some of the old scales, and showed plainly the characteristic purplish marks made by the pest.

At first Mr. Marlatt expressed considerable surprise at the heroic treatment which Captain Emory had given the trees, stating that had he applied the material in solution it would, in his opinion, have destroyed the trees. As a result of this conversation, Howard and Marlatt began an extensive series of experiments with whale oil soap for the destruction of this scale in Captain Emory's orchard, and in a large peach orchard at Riverside, Charles County, Maryland, infested with the same pest, reported in detail in their Bulletin (No. 3, n. s. Div. Ent., U. S. Dept. Agr.).

In the fall of 1895 Captain Emory followed up his experiments with whale oil soap. varying his operations somewhat by using a spray pump for applying the substance to the trees in a fine mist. That season he used over seven barrels of the soap. In the fall of 1896 he again sprayed every tree in the infested block with soap, at the rate of 2¼ to 2¾ pounds* to a gallon of water, using in all about fourteen barrels, or about 5,600 pounds. The fall of 1897 he used five barrels of soap, spraying the blocks where the scale had gained a foothold, which were not fumigated with hydrocyanic acid gas. In spite of the heroic treatment which Captain Emory has given the infested trees in his orchard, the scale has spread to a block of 2,050 six and eight-year-old Bartlett pears, 200 Lawrence pears, and has recently been found in a block of 2,500 Duchess pears, which has been fruiting for over thirty years. A few scattered specimens were also found upon a block of 140 Mountain Rose peach trees, which have been fruiting annually for the past five years. It has also gained a foothold in a block of Marietta peach trees which were planted four years ago. A few scattered specimens of the scale were also noticed this season in a block containing 1,000 Howell and a few other mixed varieties of pear. It was also found in another block of 2,000 Duchess and Bartlett pears, and upon a few trees in a block of 200 Manning's Elizabeth and 400 Buffum. In all, Captain Emory has succeeded in keeping this pest in check, but has not exterminated it.

The fall of 1897, the entire lot of Lawson pears still standing in the original block upon which the pest was introduced were uprooted and burned. These trees were destroyed partly from the fact that this variety is not considered a profitable one in Capt. Emory's locality. They were also slightly infested with the scale, and it was thought best to destroy them, together with several old apple and other trees in the vicinity, which had become infested.

A block of 450 Kieffer pear trees, planted by the side of the Lawson, from which the scale spread to all the other varieties in the immediate vicinity, have so far, been comparatively free from the attacks of this pest. After careful and repeated examination by Capt. Emory and myself, we have been unable to find a living scale upon any of these trees, with two exceptions, April 15th, 1897, after we had spent more than half an hour going over the trees in the row and along the side next to the infested Lawson block, we found four scales upon a sprout which had grown from the trunk of the tree. Three of these insects were males. and the remaining one a female, and all were alive and in apparently good condition. At another time, June 17th, 1897, we cut a sprout from one of the Kieffer trees, which contained a half dozen male scales and four females, all of which were alive. None of these trees had been sprayed. It also appears that the Le Conte pear in this locality, is practically immune from this insect, as no trace of it could be found in a block of fifty trees which were planted between a block of Lawrence and Manning's Elizabeth, both of which were slightly infested.

In the fall of 1894, Capt. Emory ordered a second lot of pear trees from the same nurseryman, from whom he had received the original lot of infested Lawson. He had been informed that the scale had been entirely eradicated from the nursery, and that the trees were perfectly healthy and in good condition. Upon receipt of the trees, Capt. Emory made a close inspection, and found them infested with the same scale. To make sure of his identification before he reported the affair to the nurseryman, he referred the matter to Dr. Howard, the U. S. Entomologist, who detailed Mr. Coquillett, one of his assistants, to proceed to Capt. Emory's place and personally examine the trees in question. Mr. Coquillett found the trees badly infested with the genuine San Jose scale. They were destroyed, and the matter was immediately referred to the nurseryman, who acknowledged he had the scale in his nursery. From recent reports, we are informed that the pest is still present in the same nursery, although heroic measures have been resorted to for its extermination.

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*This strength destroyed most of the fruit buds and some wood.

As stated above, the pest is still present in Capt. Emory's orchard to a limited extent, but every possible effort is being made to exterminate it. Through the generosity of Captain Emory and help from the Experiment Station, a long series of experiments with hydrocyanic acid gas were conducted in this orchard last fall, to which reference is made under the proper heading at another place in this report.

A recent examination of a young peach orchard belonging to Mr. H. M. Brown, planted last fall a year ago in the immediate vicinity of Capt. Emory's orchard, shows that this pest has gained a foothold upon a few of the trees. Mr. Brown's attention has been called to it, and I have written him that it will be wise for him to take some immediate action for the destruction of the pest before it spreads to other parts of the orchard, as it is now confined to the first few rows on the side adjoining the block of Bartlett pears belonging to Capt. Emory.

May 5th, 1898, Capt. Emory informed me that C. J. Reiche had three Bartlett pear trees on his place in Chestertown which had been killed by the San Jose scale. He stated that he examined the trees and that there was no question of doubt about the identity of the species. Recently, Capt. Emory received a letter of inquiry from Mrs. C. J. Ringgold, of Chestertown, stating that some insects was injuring trees which had been planted in her garden and asked for information as to what was best to do for its suppression and control. I wrote Mrs. Ringgold May 7th, that I would visit her place and make an examination of the trees and suggest the best method for controlling the insect at that time.

Still Pond:—Howard and Marlatt (Bul. No. 3), record the occurrence of the scale in the orchard of Mr. James S. Harris at this place. The correct identification of the species in this case was not ascertained, as the trees were destroyed before a specific determination had been made. In reply to a recent query, Mr. Harris says under date of November 29th: "Your letter in regard to insects on my trees is received, and the facts in the case are as follows: I bought a small lot of Lawson or Comet pear trees the same season that Capt. Emory planted his Lawson, that brought and spread the San Jose scale over his orchard. My trees were planted with Kieffer on both sides of them and a long distance from other varieties. They were badly infested with some kind of small scale insect that prevented them from growing as they should grow; and when Capt. Emory's were found to be infested with San Jose scale, I burned mine. I do not know what scale it was on my trees, but after several years of good cultivation, they were very little larger than when they were planted. The insects did not trouble the Kieffer that were on each side, but they grew finely from the first, and I have seen no signs of insects on them up to the present time. I bought the Lawson from a local dealer, and understood from him that they came from the same nursery from which Capt. Emory purchased his."

Sassafras:—While attending the annual meeting of the Peninsular Horticultural Society at Snow Hill, January 15th, 1898, Mr. James T. Shallcross, of Middletown, Delaware, told me that his brother, Jacob T. Shallcross, who resided near Sassafras, Kent county, Md., had an orchard badly infested with the San Jose scale. Upon my return to my office, January 17th I wrote Mr. Shallcross, and received the following reply January 18th: "Yours of the 17th instant at hand, and contents noted. I had an orchard of about five thousand pear trees eight years old, and so badly infested with the San José scale, that I took the entire orchard up and burnt the trees last winter. I still have about one thousand pear trees left, which look pretty good so far."

MONTGOMERY.

Ednor:—The occurrence of the scale at his place was first called to my attention by Dr. Howard, who had received specimen twigs of peach and pear infested with this insect, from Mr. E. P. Thomas. Immediately upon receipt of this information, I wrote Mr. Thomas, giving him due warning as to the dangerous nature of the pest, and called his attention to a recent Bulletin, (No. 42), which we had just issued, and further stated that I would be at his place in a few days to make an examination of the infested trees.

In company with Director Miller, of the Experiment Station, I inspected Mr. Thomas' orchard December 8th, 1897, and found that his trees were very badly infested. The trees, about 200 in number, were planted in the spring of 1894, and from the beginning, Mr. Thomas noticed that some of the pear trees, of which there were 150, were not perfectly healthful. Several of them died in 1895 and from these the scale seems to have spread to other parts of the orchard, as all of the trees were found more or less infested. There were about 50 peach trees in the lot, and part of these were literally encrusted with the scale.

Owing to the very bad condition of the trees, I assured Mr. Thomas that it would be economy in the long run to grub them up and destroy them at once, for if an attempt was made to save them by any system of spraying, the cost of such operation repeated year after year, would be more than the trees were worth. He decided later that it would be policy to destroy the entire orchard before the insect spread to other trees in his neighborhood. So far as I can ascertain, I could find no trace of the scale in the young orchard belonging to his brother, who lives near by. The infestation here was another case of the introduction of the scale directly from the nursery, as the trees came from one that is known to have been infested at that time.

Barnesville:—At the meeting of the Farmers' Institute at Rockville, December 22nd, 1896, Mr. C. C. Mainhart, of Barnesville, told me, after looking at a specimen twig containing the San Jose scale, that he was of the opinion that he had the same insect upon young trees in his orchard. Upon request, Mr. Mainhart sent me some twigs cut from his Japan plum trees January 7th. The insect, as suspected, was the San Jose scale, and Mr. Mainhart was given due notice regarding it. I visited his place April 6th, 1897, and made an examination of his orchard. I found the pest upon about 50 plum trees, the attack being very much worse upon the Japan varieties—Burbank, Satsuma and Abundance, than upon Wild Goose and Marianna. None of the trees were dead, but several were so badly infested that they had made little or no growth, and looked very sickly.

I found the same scale upon seven peach seedling about two years old in the same orchard, but did not find it upon any trees in the old orchard in the immediate vicinity. All the trees were thoroughly washed with whale oil soap, and I understand from Mr. Mainhart, that he has almost entirely destroyed it. In reply to my recent letter of inquiry, he says December 8th: "The whale oil soap saved my trees. I have watched them carefully this summer, and while there are a few scales upon them, still they are few and far between, as compared with their condition this spring. I wish you could see the trees now that were so badly infested last spring. I gave them a double dose of whale oil soap and they have made an unusual growth.

"I wish to say, however, that the soap as I applied it, killed all the blossoms and fruit buds, but later, they put out a new growth, and I never had trees look any more thrifty. To give you an idea of the wonderful growth, will say that some of them have put out over five feet of new wood quite regular over the trees.

"On the whole, I am well pleased with my success. While there are some scales upon the trees, yet I believe that another application of the soap will entirely destroy them."

At the request of Mr. John W. Brown, who resides near Barnesville. Mr. Mainhart took me to his place to see some trees which he desired me to examine. I went over his entire orchard, and found one tree, an Idaho pear, which was very badly infested with the scale. A lot of damsons had been bought at the same time, but I could find no trace of the insect upon any of them. The infested tree was dug up and burned, and the others in the immediate vicinity were washed with whale oil soap for fear that some of the insects might have escaped us.

Mr. Mainhart then took me to the farm of Mr. C. C. Brosius, who had also made a purchase of trees two years ago, the most of which, from some mysterious cause, had died. Mr. Brosius was of the opinion that they had been killed on account of the dry weather that followed shortly after they had been planted. An examination of some of the dead trees showed that they were litterally covered with the San Jose scale, and those still alive, were also infested with the same pest. In all, Mr. Brosius had purchased about 75 plum trees, 100 pear trees, and a few gooseberry and currant bushes. As noted above, all the plums and damsons were dead or badly infested with the scale, as were also all the currant and gooseberry bushes. I was unable to find any trace of the scale upon the pear trees planted at the same time in an adjoining orchard. The infested trees and bushes were in such a dwarfed and stunted condition, it was not thought worth while to try and restore them, and they were destroyed.

Brookville:—This outbreak was brought to my attention by Robt. L. Miller, who brought me a twig of an apple tree which had been referred to him by Mr. J. B. Hallowell, of Brookville. The twig was very badly infested with the San Jose scale. April 28th, 1897, I wrote Mr. Hallowell, stating that it would be to his interest to make every effort, without delay, to check and destroy this ravenous pest, and also made inquiry as to the number of trees in the orchard.

Under the date of May 4th, in answer to my query, Mr. Hallowell says: "Your esteemed favor of April 28th, duly received. The orchard contains about 75 apple trees, and a few pear and peach. 50 of these trees were planted in May, 1891, and 29 in April, 1893. I think several more are infested, though not so badly as the one, a cutting from which I sent you, though I lost one about three years ago, near the one now badly infested, and which I now believe had the same disease."

May 6th, I wrote to Mr. Hallowell, asking whether or not he would permit me to try some new soaps which had been made for me by the Powell Fertilizer and Chemical Co., of Baltimore, in an experimental way upon his trees. May 13th, Mr. Hallowell replied that he was entirely willing for me to try the experiments upon his trees, and suggested that I come to his place as soon as possible. I proceeded to the infested orchard May 15th, and began my experimental work the following day, which is reported in detail at another place in this report. I found the scale on 11 trees, two of which were very badly infested; one planted the spring of 1891, and the other April 15th, 1893. The trees made a beautiful growth, but two of them appeared to be diseased, and finally died two years ago, when they were dug up and burned. There is no doubt in my mind that the scale was introduced upon these trees, as those that are now infested are in the immediate vicinity of the places where the others were removed. Many of the twigs and limbs on the two badly infested trees were dead, and the limbs, in most cases, were literally covered. The insect was still present in this orchard August 28th, the time at which I examined a lot of twigs sent to me for that purpose. Other experiments with whale oil soap were performed in this orchard this spring.

Oakdale:—Dr. Mahlon Kirk, of this place, called the attention of Director Miller to several trees in his yard June 20th, 1897, which were supposed to be infested with the San Jose scale. The matter was referred to me by Mr. Miller June 21st, together with a specimen twig cut from one of the infested trees. I wrote Dr. Kirk the same day that the insect was the genuine San Jose scale, and gave him the information desired regarding it, and received the following communication from him June 26th: "Your letter of the 21st instant was duly received, for which I am much obliged. Mr. Miller examined the trees referred to, at my request, as I felt quite sure there was something very wrong with them. I had my suspicions aroused, but as I had not seen the San Jose scale, I felt uncertain about the trouble. He advised the use of whale oil soap, and the next day I applied it thoroughly. A day or two passed, and still feeling uneasy, as he had pronounced it an undoubted case, I concluded to treat the case heroically, and cut the trees down to within two feet of the graft, and put every leaf and stem in the stove, fragments at a time. I have again and again washed the stumps with the soap, and have bandaged them from the ground to the top, which bandages I soaked with the solution, and which I shall renew from time to time, so if there is any virtue in the soap for the trees, I hope to get it. I treat them in this manner, hoping, as the trees are a peculiar, and said to be a valuable variety, they will send off shoots from the stumps, which may still give me the apple."

Garrett Park:—Dr. L. O. Howard informed me July 16th, 1897, that Mr. Dorsett, of the Division of Vegetable Pathology, had brought him twigs from a Japan plum from the place of Mr. J. T. Allen, of Garrett Park, that were badly infested with the San Jose scale.

I wrote Mr. Allen, July 17th, stating that I would visit his place as soon as possible and make an examination of the infested trees and assist him in the destruction of the pest.

Wheaton:—The infestation at this place is in the orchard of Mr. John S. Case. He brought specimen twigs cut from an infested peach and pear tree to the station September 15th, 1897. I made an examination of this orchard, in company with my assistant, Mr. Sherman, December 8th, and found the entire orchard of 400 trees more or less infested. These trees were planted about three years ago, and were purchased from a local agent who represented a northern nursery. There seems to be little or no doubt but that the pest was introduced upon a few Idaho pear trees. Mr. Case informs me that these trees did not look healthy when he received them, and that they did not make the growth that they should, and finally several of them were dug up and destroyed. The pest has spread from this centre to all parts of the orchard, the trees in the vicinity of the original infestation being either dead at present or literally incrusted with the scale. The pear trees which are planted in alternate rows between the peach are also badly infested, but not to the same extent as the peach. I suggested that a number of the badly infested trees, which were also attacked by the yellows, should be dug up and destroyed. About 100 of the badly infested pear and peach trees will be used by me for experimental purposes; the rest of the orchard will be sprayed with whale oil soap, and every effort possible will be made to check and destroy this ravenous pest before it spreads to other orchards.

It was with difficulty that the scale was found upon Kieffer pear trees, which were surrounded by badly infested peach trees. It is certainly apparent that trees of this variety in this locality are practically free from the attacks of this pest. The little black lady bug (*Pentilia misella*) was quite abundant upon the infested trees.

Fairland:—Mr. Wilson G. Johnson, of this place wrote me October 20th, 1897, making inquiry for a remedy for the destruction of the

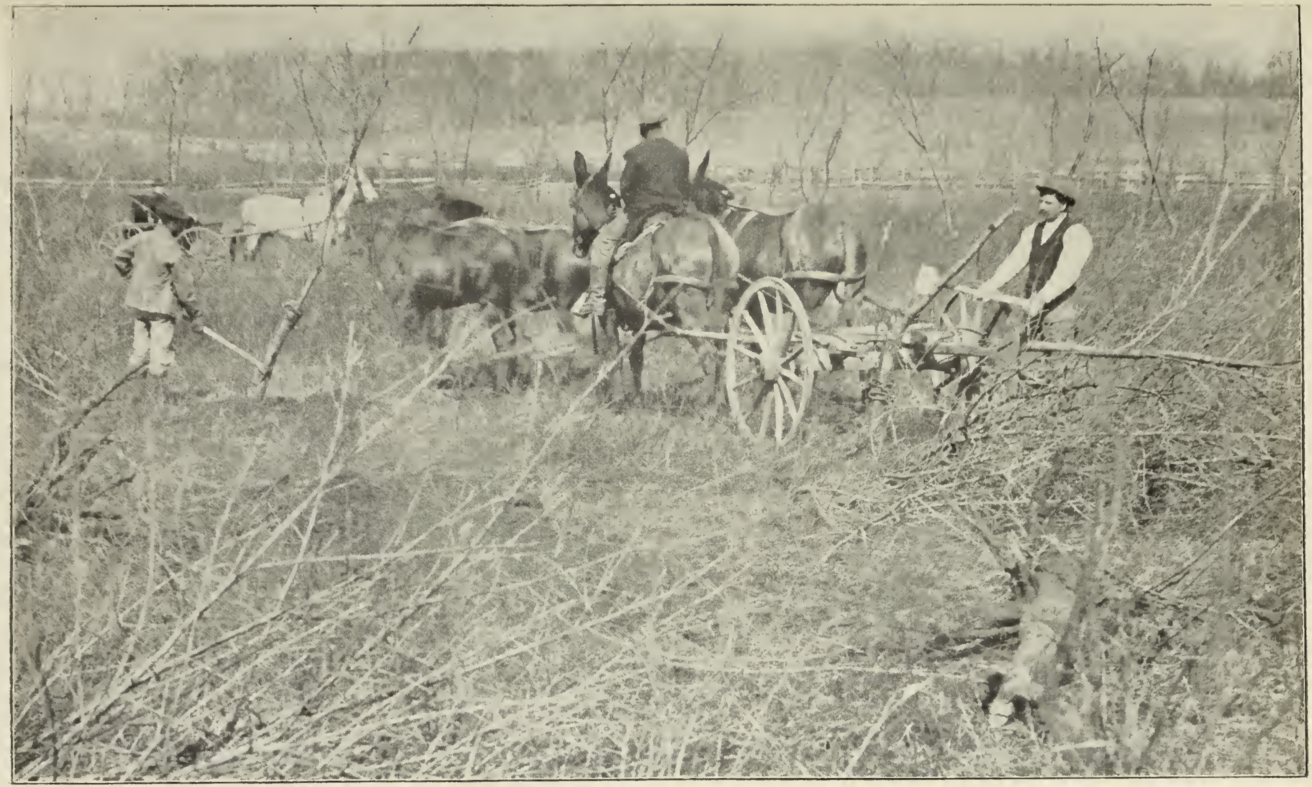

Figure 5.—Removing a peach orchard killed by the San Jose scale. Photo. taken March 8, 1898, by W. G. Johnson.

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San Jose scale. In reply to Mr. Johnson's letter, I asked whether or not the scale had gained a foothold in his orchard or in his neighborhood, and received the following answer December 2d: "In reply to yours of the 25th instant, would say, that I purchased 50 peach trees this fall a year ago, and planted them in my orchard. The trees did not please me in looks, and having seen specimens of peach infested with the San Jose scale, I made an examination of my trees. I did not have a very good glass for the purpose, but two of the trees were in such a bad condition that I concluded to destroy them. I decided to use whale oil soap on the others, and not knowing whether it would injure them, I wrote you, knowing you could give me the required information.

"I do not suppose there are 500 peach trees within a radius of five miles of my place. This was quite an extensive peach neighborhood several years ago, but on account of the yellows, the trees have been destroyed, and the farmers have ceased planting. In conclusion, I would say, that it was my original intention to have set out 500 trees, but my neighbors advised me not to do it, consequently, I began with only 50, as indicated above."

Burtonsville:—The infested trees at this place are in the orchard of Benjamin Atley, and were purchased two years ago from a New Jersey nursery. Mr. Albert Miles brought twigs to the experiment station for examination February 24th. They were cut from an Idaho pear, and were badly infested with the San Jose scale. Mr. Miles tells me there are about 500 trees in the orchard, but only about a dozen seem to be infested at present. He also stated that a number of his neighbors had purchased trees at the same time and from the same firm. A few days later, Mr. Miles brought pear twigs from other orchards in his vicinity, but I could find no trace of scale upon them.

Sellman:—April 16th, 1898, I received a number of apple twigs from S. D. Mainhart, of this place, infested with scale insects, and upon examination found that one of them was the scurfy scale and the other very badly infested with the San Jose scale. The trees were planted two years ago this spring, and I am informed by Mr. Mainhart, that he has taken out the badly infested ones and burned them. These trees were planted in the vicinity of a peach orchard.

PRINCE GEORGE'S.

Mitchellville:—The outbreak at this place was first recorded by Howard and Marlatt (Bul. No. 3). Mr. Coquillett was detailed to investigate the outbreak December 21st, 1894, and found that the pest had originated upon some Japan plums brought from California. The infested trees were immediately uprooted and burned by the owners. A second inspection was made in November, 1895, by an assistant of the department of agriculture, who found two trees slightly infested, which were immediately destroyed.

I first visited this place August 31st, 1896, and found the scale still present upon Howell, Lawrence, Bartlett and Comice pear. All the infested trees were destroyed by fire. September 3rd, 1896, I found the same scale in a small pear and plum orchard in the immediate vicinity of the place where the other outbreak was discovered. The pest was especially abundant upon a few Garber pear, and from a few plum trees from a southern nursery. All the infested trees were immediately destroyed, and it was suggested that the others should be sprayed with whale oil soap. At the time of my visit to this place October 12th, I found that the entire orchard had been sprayed with soap at the rate of 2½ pounds to a gallon of water. I found, however, that the scale was still present on several Garber pear trees, and suggested that the best method would be to destroy them without delay. This same orchard was again examined March 22d, 1897, at which time, I found still other trees badly infested. They were dug up and used for experimental purposes with hydrocyanic acid gas. The same scale was discovered upon Garber and Bartlett pears August 2d, and upon Early Purple Cherry August 3rd, 1897. The pest was also found upon this place on a large number of varieties of pear, plum, apple and other trees, all of which are named at another place in this report. The infested trees, wherever they were found, were either uprooted at the time, or marked, so that they could be located and removed afterwards. In all, about 15,000 trees were found more or less infested, and were destroyed without delay.

August 3rd, 1897, at the request of Mr. Henry McGaw, I visited the extensive orchards of McGaw, Davis & Company, which are located near Mitchellville. These orchards are among the largest in the state, and cover over 300 acres. The first trees were planted in May, 1888, consisting of over 20 varieties, aggregating 9,566 trees. In December, 1889, 4,925 trees of seven different varieties were set out in the same orchard. In November, 1890, 3,700 trees of two varieties were planted, and in April, 1891, 10,120 trees of five varieties were planted, making a total of 28,311 trees in the entire orchard.

After inspecting the trees of various varieties planted at different times, I was horrified when I discovered the San Jose scale in a block of Mountain Rose. These trees were planted in May, 1888, and had made a magnificent growth, and contained some fruit of an inferior quality on account of the peach rot (*Monilia fructigena*), and the attacks of the scale, which caused a peculiar depression in the fruit, giving it a gnarly appearance. The peculiar purplish tinge which accompanies this insect where it attacks a twig or the fruit, was especially conspicuous on these peaches, and the tinge penetrated the fruit to a depth of from one-sixteenth to one-eighth of an inch. From the growth these trees had made, it was apparent at a glance that the pest had not been introduced upon that particular variety. It did not take long, however, to ascertain the source from which the pest had spread, as in a block of 2,200 Wheatland, the scale was everywhere present, and hundreds of the trees were dead and dying from its attack. (See Figures 3 and 4). It was not difficult to locate that particular part of the orchard where the trees were planted which bore the original infestation. The trees which were infested when they came from the nursery had long since died out, and not a vestige of some of them was left, but the growth of the trees surrounding the spots where the first trees had died was very peculiar. For instance, the trees that had been in the immediate vicinity of the infested one had made a very good growth a year or two later, and then succumbed to the attacks of the insect. Adjoining these, other trees had become infested, showing that they had made from four to six years growth before the scale had appeared in destructive numbers upon them. This condition of affairs could be easily traced throughout the orchard in the various blocks where the pest had been introduced.

My letter of August 16th, 1897, addressed to the firm McGaw, Davis & Company, contains some points of general interest in this matter, and I quote it here in full as follows: "Gentlemen:—On August 3rd, at the request of your representative, Mr. Henry M. McGaw, I visited your extensive peach orchard in the vicinity of Mitchellville, Prince George's county, this state, and made a careful examination of the trees.

"I find the San Jose scale has gained a foothold in your orchard, and is responsible to a very large extent, for its present depleted condition. It is not necessary for me to say that this is the most dangerous insect pest that has been introduced into American orchards, as a glance at your orchard in its present condition, would convince the most skeptical that this ravenous pest is a deadly enemy to our deciduous fruit trees. Neither is it necessary for me to enter into a detailed discussion as to the origin of this pest, but will say, that it was unknown to the general public in the eastern United States previons to 1893. It has long been a scourge in the orchards of California, and was accidentally introduced from there on nursery stock in several New Jersey nurseries about 1887, and from them, has been gradually disseminated throughout our eastern orchards and many other nurseries.

"From my careful examination of your orchard on the 3rd and 6th instant, I am led to conclude that the insect, without a doubt, was introduced upon peach trees from the nursery the fall of 1890 or the spring of 1891. The present condition of the orchard reveals the fact that the trouble started originally on the following varieties: Reeves, Geary's Holdon, Smoch, Wheatland, Crawford's Late and Crawford's Early. From these varieties, the insect has spread to others, and in many instances, has killed a large number of the trees. It is quite reasonable to say, that at present there are at least 13,000 trees badly infested, all of which are either dead or dying from the attacks of this insect. From the present condition of affairs, I would advise you to have the orchard dug up and burned as soon as possible, as there is great danger of the insects spreading to various trees, shrubs and other plants in their immediate vicinity, where it would be impossible to exterminate it.

"This outbreak is by far the most serious attack I have ever seen, and for your protection and the protection of others in the vicinity of your orchard, I would advise its destruction as soon as possible. If I can be of further service to you in this matter, do not fail to let me know."

As I have indicated above, this is by far, the most serious outbreak of the scale that has yet come to my notice in this state, and it is to be regretted that it gained a foothold in such an extensive orchard as this one. The orchard was planted with the view of using the product for commercial purposes, and an extensive cannery was erected in the immediate vicinity. I am informed that that part of the orchard planted in 1888-89, has borne only one good crop of peaches. The later plantings have been so reduced by the scale, that few of the trees remaining have borne fruit. Everything possible has been done by the owners of this orchard to make it a profitable one, but in spite of their cultivation, fertilization, etc., the trees have been dying from year to year, and its present condition is due largely to the attacks of the scale. Some of the trees have been injured to a considerable extent by the peach tree borer. There is also an indication that the trees in some parts of the orchard have suffered from severe cold weather. On the whole, the trees were in such miserable condition, it seemed useless to try to restore them, so that they would in the future, be of any value whatever.

I took several photographs of this orchard from various positions August 6th, and reproduce two of them as Figures 3 and 4. These views were taken in a block of 2,200 Wheatland, planted in April, 1891, and give a very graphic idea of the present condition of the orchard in mid-summer. The views look more like mid-winter than mid-summer scenes, when the trees should be in full foliage. It is not possible for me in this place to describe in detail all the minor particulars regarding this infested district. Suffice it to say that the owners have left nothing undone on their part to eradicate this deadly enemy.

In reply to a recent query regarding this orchard, Mr. Geo. K. McGaw writes me December 20th, as follows: "It is our intention, and we are now at work on its execution, to destroy the entire peach orchard, consisting of something over 28,000 trees."

In conversation with Mr. McGaw December 17th, he told me that twenty-five thousand dollars cash would not compensate him for the loss he had sustained from the attacks of this ravenous pest in his orchard, to say nothing of the loss of the use of the 300 acres of land for nearly eight years.

I visited these orchards March 8th, 1898, and found a force of men at work grubbing and pulling up the trees. About 10,000 had been uprooted and the whole place was a scene of desolation. Nothing but stumps, roots and piles of brush as far as one could see. A fair idea of the method employed in removing the trees, and the general appearance of the orchard can be gained from figures 5 and 6.

March 8th, 1898, I found the scale was just beginning its establishment in a twelve-year old peach orchard, belonging to Mr. Peach near Mr. McGaw's place. The trees are badly shaped, but have made a very good growth, and are well set with fruit spurs. The scales are noticeable on the young fresh growth.

There is also another old orchard in the vicinity of Mitchellville, into which this scale has gained a foothold. The orchard contained very few living trees, and none of them were of any special value. It was suggested that all the trees be grubbed up and destroyed, and I am informed that this suggestion has been carried out. Was at this place March 8th, 1898, and find all the trees have been destroyed.

T. B. Post Office:—The infestation at this place was brought to the attention of Dr. Howard in August, 1895, by Mrs. E. L. Nixon. In all, there were about twenty trees found badly infested, some of them having died. They were planted in the spring of 1891, and made little growth.

To a recent inquiry as to the condition of this orchard, Mr. Nixon writes December 8th, as follows: "The scale has simply taken our orch-

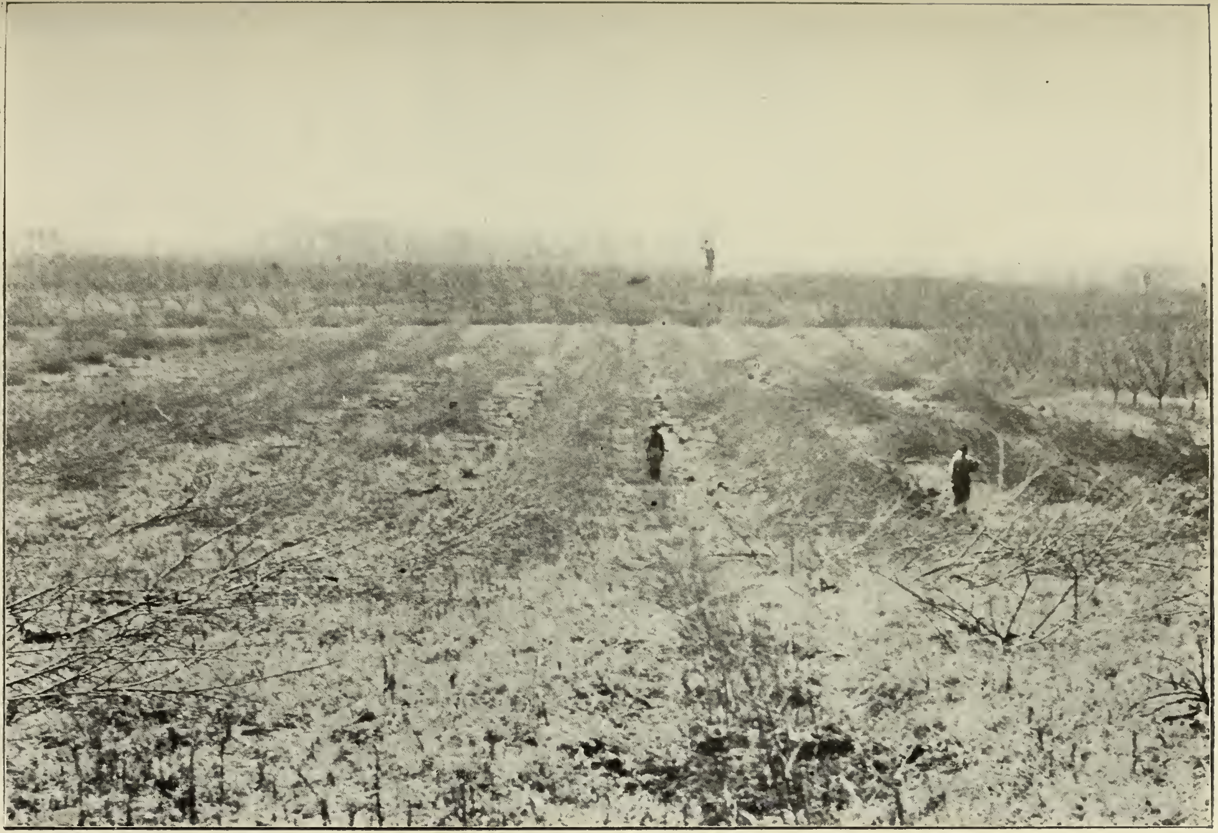

Figure 6.—Cutting down a peach orchard destroyed by the San Jose scale. Photo. taken March 8, 1898, by W. G. Johnson.

ard of 450 trees, which was just coming into bearing. It has spread to our Japan plum trees now, and I presume will kill them next. The most of the peach trees are dead, and we shall cut and burn the entire lot. The trees were purchased six years ago last spring, and had the scale upon them at that time, but we did not know what it was until about two years ago."

Berwyn:—The scale at this place was found by Mr. F. C. Pratt upon a single plum tree in January, 1896, on the premises of Mr. J. C. Brelsford. So far as observations went at that time, it was not detected on any of the adjoining trees. The original tree was dug up and taken to the U. S. Department of Agriculture for experimental purposes.

A recent examination of the trees on this place by my assistant, Mr. Sherman, shows that the pest is still present upon several trees. Mr. Brelsford informs me that he will wash all the trees with whale oil soap before spring. Mr. Sherman was unable to find the scale upon trees in any of the adjoining premises.

QUEEN ANNE.

Centerville: In a communication from R. S. Emory April 17th, 1898, I was informed that his brother, Frank, of this place, who had been in Baltimore at the horticultural convention and listened to the proceedings, had examined the trees in his orchard upon his return home, and found the San Jose scale upon trees he had purchased from a New Jersey nursery several years ago.

Specimen twigs were sent to Capt. Emory for examination. Upon receipt of this information, I immediately wrote to Mr. Emory at Centerville, asking for definite information regarding the outbreak, and found that he had purchased 400 Bartlett pear trees in 1889, from a New Jersey nursery. He says they were a miserable lot of trees when received, and he hesitated before planting them. The trees have never been healthy, and few of them have been dying year after year. He informed me that since he had learned definitely that it was San Jose scale upon them, he ordered the entire lot taken up and burned.

SOMERSET.

My attention was first called to this outbreak January 20th, 1897, by Mr. E. E. Matthews, who resides in Somerset county, near Pocomoke city. He wrote to the Agricultural College, asking for information about the San Jose scale, as he was of the opinion that he had it upon trees in his orchard. Upon receipt of this information, I wrote Mr. Matthews, asking for specimen twigs for examination, and received a reply, together with the twigs, February 6th. As was suspected, the twigs were very badly infested with the San Jose scale, and further inquiry revealed the fact that the trees came originally from a New Jersey nursery seven or eight years ago, and that most of the apple and pear trees bought at that time have since died. The pest has spread to other trees in the immediate vicinity, and has seriously checked their growth. I am informed that many of the infested trees have been dug up and destroyed, and everything possible will be done to check the further spread of the pest in that neighborhood.

I visited Mr. Matthews' place January 14th, 1898, and made an examination of his trees. I find the scale has spread to a very great extent throughout his orchard, and many peach trees have been killed by it. About 500 trees have been taken up and burned. I find a number of pear and almond trees have also been destroyed by the pest. It is present upon a large number of pear, apple and peach trees. I also found it had gotten into an old peach orchard some distance away from the trees originally infested.

I was much pleased to see the great number of varieties of fruits and nuts Mr. Matthews had on his place, and it is to be regretted that the San Jose scale has gained a foothold in so promising an orchard. Nothing will be left undone to check its spread.

TALBOT.

Neavitt:—The first outbreak in this county was recorded by Howard and Marlatt (Bul. No. 3), and was brought to their attention May 19th, 1894. The orchard consists of about 14 acres belonging to Mr. J. H. Reip, and is situated on an inlet of the Chesapeake Bay. The orchard consists mostly of peach trees, with about four acres of apple, cherry, plum and pear trees. The age of the trees range from one to eight years, and practically all of them were infested. There is little or no doubt but what the pest was introduced at the time the stock was purchased, but the source of the infestation is uncertain, as the trees came from several different nurseries.

In reply to a recent letter of inquiry regarding the present condition of this orchard, Mr. James D. Haddaway says: "At the request of Mr. J. Henry Reip, whose orchard I am looking after, I herewith give you a short account of how I have been fighting the San Jose scale for the last three or four years. I discovered something was wrong with some of our trees in the spring of 1894, and not knowing what the trouble was, I sent cuttings to the U. S. Department of Agriculture for examination, and soon received information that the trees were badly infested with the San Jose scale. Mr. D. W. Coquillett, an assistant of the division of entomology, came and made a thorough examination of the trees. At that time, we had about fifteen hundred peach trees, about four years old, so badly infested that more than one-half of them were destroyed. We also had four of five acres in young apple, pear, and cherry trees, which were also infested, but not so badly as the peach trees. On these trees, I have been working to destroy the insects. While I have not succeeded as I could wish, I am satisfied that the extermination of the pest can be accomplished, if every person having an infested tree would either destroy it, or apply some remedy for the destruction of the scale, and it seems to me almost useless, unless this is done. Spraying with kerosene emulsion is the remedy I would recommend as being the best I have ever tried, and any time after the trees shed their foliage the best time to apply it."

Easton:—Specimens of this pest were sent to the experiment station by Mr. A. H. Larrimore, October 9th, 1896, who took them from trees on the premises of Mr. Fred. Thom. about two miles north of Easton. I visited this place in company with Mr. Larrimore November

18th, and found the trees very badly infested. The orchard was a small one, consisting of fifteen peach, six apple, and a few other trees in the immediate vicinity. The scale was present upon all of them, but was especially abundant on the apple, several of which had died from its attacks. It had also spread to a number of ornamental shrubs planted in the dooryard. An examination of a few peach trees some little distance from Mr. Thom's place showed that the scale had also gained a foothold upon them, but had done no special injury up to that time. Upon inquiry I found that the trees had been purchased originally by Mr. August Hemmerle about four years ago from a Philadelphia nurseryman.

I went to Mr. Himmerle's place, but was unable to find any indication of the scale in his orchard. He informed me that some of the trees had died prematurely, but he was not sure that they had died from the attacks of the scale. A careful examination of the trees in the immediate vicinity of those that had died showed that the scale had not gained a foothold upon them, and I am therefore of the opinion that the pest was introduced only on the trees which were sold to Mr. Thom. Mr. Thom was advised to destroy the badly infested trees and treat the others with whale oil soap.

WASHINGTON.

Sharpsburg:—Mr. Joseph H. Cox, of this place sent specimens of diseased peach twigs to the experiment station for examination the fall of 1894. These twigs were submitted by Prof. Robinson to Dr. Howard, of the U. S. Department of Agriculture for determination, December 2d. This orchard is situated about three miles north-west of Sharpsburg, on the Potomac river, and there is no doubt but what the scale was introduced upon a certain variety of trees at the time they were purchased from the nursery.

In reply to recent inquiry regarding the present condition of this orchard, Mr. Cox says, under the date of November 27th:—"Mr. Coquillett examined my orchard in March, 1895, as you stated in yours of the 23rd instant, and he ordered about 40 trees taken out, suggesting that the other infested trees should be sprayed with whale oil soap at the rate of two pounds to a gallon of water, which made it very strong. There were about 1,000 trees in the orchard, planted in 1891, and I sprayed them with soap as directed. I thought I had conquered the pest until the fall of '95 and the spring of '96, when I noticed it on the trees worse than before. I then sprayed them again with soap, using the same quantity to the gallon of water as before, but it did not destroy them, as they got worse instead of better. Last winter I pulled the trees up and burned them, root and branch, and raised a crop of corn in that field this season.

"I have an idea for the destruction of this pest which I desire to give you, and hereafter if I have any bother with that pesky creature I will try it. My plan would be to saw the tops out of the trees, and then singe the trunks and larger branches with a torch. I am of the opinion that it would not injure the tree while in a dormant state. Let me hear from you about this idea."

Mr. Charles G. Biggs, of Sharpsburg, wrote Dr. Howard, November 30th, 1895, that the scale had made its appearance in the orchard of

Biggs & Showman, three miles south of Sharpsburg. By request, Mr. Coquillett visited the locality January 30th, 1896, and made an examination of the infested trees. He found that the pest had been introduced upon peach trees, and had spread to a considerable extent throughout the orchard, as about a thousand trees had already contained the scale. A number of the badly infested trees had been dug up and burned. It was suggested that the moderately infested trees be sprayed with whale oil soap without delay, and I am informed by Mr. Biggs that the material was applied as carefully as possible. Mr. Biggs had been very energetic in his warfare against this pest, and has left nothing undone to check its spread in his extensive orchards. He was one of the first to see the very great danger of the destruction of the orchards by this insect, and in 1896, appeared several times before the legislative committees in behalf of remedial legislation.

In reply to my recent letter, making inquiry about the present condition of his orchard, Mr. Biggs writes, November 26th, as follows: "Three years ago, I discovered the San Jose scale in our, that is, Biggs and Showman's orchard. We immediately applied whale oil soap in the proportion of two and one-half pounds to the gallon of water, and I thought we had the pest under control, but this year it has again appeared on about three or four hundred trees, though not in as great quantities as before, showing the impossibility of reaching all the scale by spraying, no matter how carefully the application is made. We are now topping all the badly infested trees, destroying the excised branches and thoroughly washing the portions left standing with a strong solution of the soap. If we fail to eradicate it this time, we will top all infested trees and treat the stumps, which will form new, healthy heads in two years. Our orchard is three miles south of town, on the mountain."

By appointment, I visited Mr. Biggs' orchard January 21st, 1898. Mr. S. S. Stouffer. of Sharpsburg, Professor F. M. Webster,the entomologist of the Ohio Agricultural Experiment Station, who was my guest, and Mr. Biggs, accompanied me to the orchard. We found a very bad state of affairs. Instead of finding between three and four hundred trees infested, as we expected, we found between three and four thousand. Many trees here and there on the lower side of the orchard were literally covered with the pest, and it had pretty generally distributed itself throughout a block of about four thousand trees up the side of the mountain in the direction of the prevailing winds. It was one of the most striking examples of the spread of this insect by the wind that I have ever seen. Between four and five hundred trees have been cut down and burned, while many others have been cut back to the stumps and treated with whale oil soap. I have advised the cutting out and destruction of all the badly infested trees, the immediate pruning of all slightly infested ones and their thorough spraying with whale oil soap. The spraying to be repeated again in the spring, and a third time next fall.

Mr. Biggs called my attention to another outbreak of the scale in the vicinity of Sharpsburg, on the place of Mr. Samuel H. Neikirk. Part of the orchard has been cut down and destroyed this fall. In reply to a recent letter of inquiry, Mr. Neikirk says, under date of December 10th:

"My reply to your inquiry has been delayed from the fact that I desired more definite information about the original source of my trees. I bought 3,500 peach, a few apple and cherry trees in the spring of 1891, from a local dealer of Hagerstown, who has since discontinued the nursery business. He purchased his peach trees from a Virginia nursery. I believe my peach trees were infested when I got them, although I did not notice anything wrong at first; but in a few years their condition clearly indicated that they were not heathful.

"I discovered the real cause of the decay of my orchard this spring, and could hardly believe it. A number of fruit buyers were in my orchard this spring, but none of them knew what was the matter with the trees. About 2,000 trees were infested, and many of them were killed this season with fruit hanging on the twigs. Most of them had one or two limbs badly infested which were dead, and the rest of the tree literally covered with insects. It took me but a very short time to conclude that the sooner they were all reduced to ashes the better."

I visited Mr. Neikirk's place January 21st, 1898, and inspected this orchard, as well as another in the immediate vicinity. Mr. Stouffer, Mr. E. A. Pry, and Mr. Neikirk's two brothers accompanied me. I found about two thousand peach trees had been cut down, and the stumps and many piles of brush remaining on the ground. There were about twenty-three hundred trees still standing in the orchard, and I found the scale more or less abundant wherever I went. It does not seem advisable to try to save any of the trees, they are in a frightful condition, and it will be economy to destroy them at once. Last spring Mr. Neikirk set out several hundred plum trees and I find the scale has established itself upon them. They were planted along side of the badly infested block of peach. He also has a lot of peach trees heeled in, which he has intended to plant in the same orchard this spring, but I have strongly urged him not to do it.

Still another infested orchard near Sharpsburg was brought to my attention by Mr. Neikirk in his letter of December 10th. It is on the place of Mr. James Snyder and adjoins Mr. Neikirk's orchard. I made an examination of this orchard also, January 21st, 1898, and found the trees in very bad condition. The most of them were dead. About nine hundred trees adjoining Mr. Neikirk's orchard had been dug up and the ground planted in wheat last fall. The remaining two thousand trees were in such a frightful condition, nothing can be done to save the few hundred that still remain alive. From the indications, it seems quite likely that the pest came into Mr. Neikirk's orchard from Mr. Snyder's, and I am inclined to hold to this opinion until I get further facts bearing on the infestation. In reply to my letter of March 26th, 1898, Mr. Snyder informs me March 27th, 1898, that the orchard has been cut down; but I found upon personal inspection, that a few trees only had been destroyed, and that between 1,400 and 1,500 trees are still standing, which I have since had destroyed.

Shockey's Station:—Mr. C. W. Reichard, of Hagerstown, informed me February 3rd, 1897, that he had the San Jose scale in his orchard, which is located about two miles from Edgemont, near Shockey's station. He said the trees were originally purchased from a local nurseryman, Mr. W. S. Reichard, who has since gone out of business. In a letter dated December 2d, 1897, Mr. C. W. Reichard says: "Replying to your communication of the 30th ultimo, would say, that in the fall of 1892, I planted about three hundred pear trees in an orchard where there had already been set 125 pear. In the fall of 1895, I discovered several trees, planted 1892, diseased, and during the winter established the fact that they were affected with San Jose scale. In the spring of 1896, all diseased trees that I discovered—to the number of six or eight, were dug up and burned; these were Bartletts. I soon discovered that quite a number of Bartlett and Duchess were more or less affected. In November of 1896, I sprayed the orchard thoroughly with whale oil soap. During the early part of the summer of 1897, I could not discover any of the scale, but at present writing find a few scattered on trees in different parts of the orchard.

"From my observation and experience I am satisfied that whale oil soap is death to the scale when it gets on them properly. The trouble is to reach all the pests with a spray."

Regarding the source of these trees, Mr. W. S. Reichard writes me December 15th, 1897, as follows: "As to Mr. C. W. Reichard's trees, I do not know positively where they came from. I was not raising any pear at that time, and he bought them, I think some place near Rochester, N. Y."

Brownsville:—Mr. J. P. Blessing, of this place, sent specimen twigs cut from trees in his orchard infested with the San Jose scale to the station for examination March 11th, 1897. He says: "I got the scale into my orchard on pear trees, and have fought them for three years with kerosene emulsion, potash, etc. The most effective wash I ever applied was bichloride of mercury, but it is too dangerous a poison to use as a spray. I have kept the scale in check, but have not exterminated it."

The condition of the orchard at present is told in a letter received from Mr. Blessing, December 2d, and is as follows: "Replying to your favor of the 30th ultimo, would state, that the San Jose scale was introduced into my orchard upon pear nursery stock. From the pear trees, the scale spread to an adjacent peach orchard containing 6,000 trees. Some 50 or more trees were completely incrusted with scale in the course of one season, and 200 more trees were infested; all of which I pulled up and burned; but outside of the trees destroyed were a considerable number of scale-infested trees. Last fall I gave these trees a spraying with kerosene emulsion. In December, I had a carload of air-slacked lime thrown among the branches while the trees were damp, which adhered to the trees for weeks. This was followed this spring by a spray of whale oil soap, applied as hot as could be handled. All of these applications reduced the scale, the whale oil soap being the most efficient. But in spite of all my efforts to exterminate this terrible foe, I would never have succeeded but for an invasion of lady bugs. I found them everywhere in my orchard during July, August and September. I made diligent search during October and November for live scale, but failed to find a single one. I think it was six years ago that I planted the scale-infested pear trees. Most of my peach trees had been planted two years before."

Cavetown:—The infestation at this place is in the orchard of Messrs. John and Jacob Hoffman, and was inspected by me October 8th, 1897. As nearly as I can ascertain, the trees were purchased in the fall of 1891 or 1892. The orchard is a small one, containing not over 500 trees, and the most of them have made a beautiful growth. Many of the trees this year have shown signs of decay from the attacks of the San Jose scale. It was not difficult to locate the trees in the orchard where the original infestation occurred. The pest seems to have been introduced upon a few trees which have since died, and spread the contagion to others in the immediate vicinity. There were about 50 trees in the vicinity of those that had died out from the attacks of the scale. They were literally covered with the pest from top to bottom, and it was almost impossible to see the bark at any point. Mr. Hoffman had seen the sickly condition of these trees and had gone into the orchard the evening previous to my visit and had cut off the branches of the badly infested trees, leaving only the trunks standing. The scale had spread throughout the entire orchard, and was found at the opposite end on a small apple seedling that had come up one year ago. The whole orchard was so generally infested I advised its destruction, and I have since been informed that it has been destroyed.

I also found the scale upon young peach trees in a large orchard on the opposite side of the road, which was planted last spring, belonging to Mr. Diffendal. A careful examination of these trees showed that three-fourths of them on the first three or four rows adjoining the Hoffman orchard were slightly infested. The same pest was also found in an old orchard nearby belonging to Mr. Davis. Many trees in this orchard were dead and dying from the attacks of the yellows, and the place had been somewhat neglected. Both Mr. Davis and Mr. Diffendal were informed that the scale had gained a foothold in their orchards, and were advised to take immediate steps to check its further spread.

There is little doubt but what the pest was introduced into the Hoffman orchard at the time they were purchased from the nursery, and has generally spread to other trees in the same orchard, and from there to the other places mentioned above.

Smithburg:—The attack at this place is in a large peach orchard on the side of a mountain, and the pest seems to have originated on a few plum trees purchased about three years ago and set out in the orchard between the peach trees. The plum trees have since died, and other trees have been set out where they stood. From a general inspection of the orchard it appears that the pest has as yet confined its attacks to about 25 trees in the immediate vicinity of the place where the plums were planted. These trees are only moderately infested. At the time of my examination, October 7th and 8th, I found about 200 Ben Davis apple trees in the same orchard were slightly infested. It was suggested that the infested ones should be destroyed, and all other suspicious trees in the same block should be either fumigated with hydrocyanic gas or sprayed with whale oil soap.

Edgemont:—October 4th, 1897, I received a specimen pear from Mr. Samuel B. Loose, of Hagerstown, who stated that it had been taken from his orchard near Edgemont. He was apprehensive that the condition of the pear was due to the attacks of the San Jose scale, and sent the specimen for examination. I wrote him immediately that the creature was the genuine San Jose scale. I stated also that I expected to be in the vicinity of his place in a few days, and I would call upon him and make an examination of his orchard. I examined the orchard October 7th, and found the scales upon some pear trees that had been planted some four or five years. The trees had not made a very good growth, and several of them were literally covered by the scale. Mr. Loose first discovered it on some fruit he was packing, and suspecting what it was, sent me the specimen for examination. I found the pest had spread to possibly 50 or more trees in the orchard, and the trees upon which it was originally introduced, had been dead for some time. Mr. Loose does not know from whom the trees were purchased, as he has but recently bought the farm. I was unable to find the scale in an adjoining quince orchard, and am of the opinion that it has confined its attacks to the pear. Mr. Loose assured me that he would leave nothing undone on his part to check and destroy the insect in this orchard.

Trego:—While attending the meeting of the Horticultural Association of Western Maryland, at Hagerstown, January 22d, 1898, Mr. D. D. Keedy handed me a small twig cut from a plum tree on the premises of Mr. H. C. Rohrer, and asked me to examine it. At first glance, I saw that it was badly infested with San Jose scale. Upon inquiry, I found that only one tree, so far as determined at present, was infested. It was purchased from a local dealer two years last fall. My advice was to dig up and destroy the tree as soon as possible, and treat all suspicious ones with whale oil soap before the buds open. In reply to my letter of inquiry, Mr. Rohrer writes me that he had only fifty trees in all, and so far, he can see only one infested.

Boonsboro:—March 15th, 1898, I receievd a specimen twig cut from an apple tree by Caleb Long, of this place, stating that in his judgment the twig was not infested with the San Jose scale, but some other species. Upon examination, however, I found that the insect was the genuine San Jose scale. Fortunately for Mr. Long, this apple orchard only contains 50 trees and only two of them were found infested with the scale. The trees were purchased from a Pennsylvania nurseryman, and nothing will be left undone on Mr. Long's part to completely control and suppress the insect in his orchard. He says: "I apply the sure remedy, the ax."

GENERAL RESULTS AND PROBABLE OUTCOME.

From the foregoing facts, it is evident that the scale is very generally distributed, and it will be some time before it ever can be exterminated in this state. The only places where extermination has actually been accomplished, are in orchards and nurseries where all the trees have been uprooted and burned. It is hard to realize what havoc this deadly pest has occasioned in the orchards of this state, even after considering what has already been said; but by summing up the situation in figures, the magnitude of the attack is apparent.

The 95 infested orchards contain 157,165 bearing trees, of which

58,620 were infested, and 50.343 of these have been killed from the attacks of the scale during the past four or five years, and have been dug up and burned. This leaves still standing 8,277 infested trees in the midst of 106,822 bearing trees in their prime. Aside from the above, 21,577 nursery trees have been destroyed, making a total of 71,920. The actual loss in dollars, of course, cannot be determined, but figuring the cash value on taxable basis, the owners of these trees have lost $68,897.00, to say nothing of the loss of land, labor, crops, etc. The losses to individuals vary from a few dollars up to the enormous sum of $25,000.00. In several instances, the orchards have been completely swept out of existence in a few years, and the cause was not ascertained, until the work of the deadly enemy was completed.

In view of all these facts, one might say, that the outlook for the future orchardist was very discouraging. Indeed it is, but this pest need not run fruit growers out of business. If we continue our inspection and fumigation work in the nurseries, we can soon control the principal source of danger. It remains, therefore, for the grower to be more alert himself, and when a tree dies, if the cause is not apparent, it should be ascertained if possible, without delay. In a great many cases in this state, the orchardists knew their trees were not thrifty and healthy, and that many of them were dying in spite of the most careful tilling, pruning and fertilizing. When this condition confronted them, they should have sought expert investigation, which was at their command, simply for the asking. Such negligence is excusable the first time very often; but a man does not usually lose a second 1,500 or 2,000 trees before he knows what the difficulty is.

By prompt action, backed by state legislation, I am confident we will successfully control the San Jose scale in this state, if we apply intelligently the remedies that have already been tested, and found effective. To succeed, we must locate all infested orchards, control the nurseries, and insist upon a written guarantee by a qualified officer with nursery stock, as well as inspect and watch the trees after they are set out. We are now enforcing this system in this state, and we have the scale now reduced to a minimum, so that there is no danger of its future spread.

NATURE OF ATTACK AND GENERAL APPEARANCE.

On badly infested trees, the San Jose scale attacks the leaves as well as the trunk, branches and fruit. It is a very common thing to find trees covered with the scale to such an extent that it is not possible to see the bark at any point upon the trunk and larger branches. In such instances, the trees usually have a grayish or ashy appearance. This is due to the coating of the delicate little shell-like scales which have become somewhat bleached by the weather. Normally, the scales are almost black when half grown, but become lighter as the insect matures, and when a tree becomes coated with them, it has the grayish or ashy appearance described above. One can easily scrape off the scales with the thumb nail, providing the tree is still alive, in which case there will be an oily substance caused by the crushing of the insects under the scales. If, on the other hand, the tree is dead, the scales are not so easily detached, and the oiliness is absent from the fact that all the insects are dead and dried up.

The real appearance of the scale cannot be detected by the average eye sight, without the aid of a magnifying glass. If an infested twig is examined with a hand lens, it will be seen that it is coated with shell-like objects, varying in size, shape and color. It resembles very much a stick covered with barnacles. If the examination is made in the summer time, the young, yellowish lice would be seen crawling about and over the scales, as shown in the illustration at figure 7.

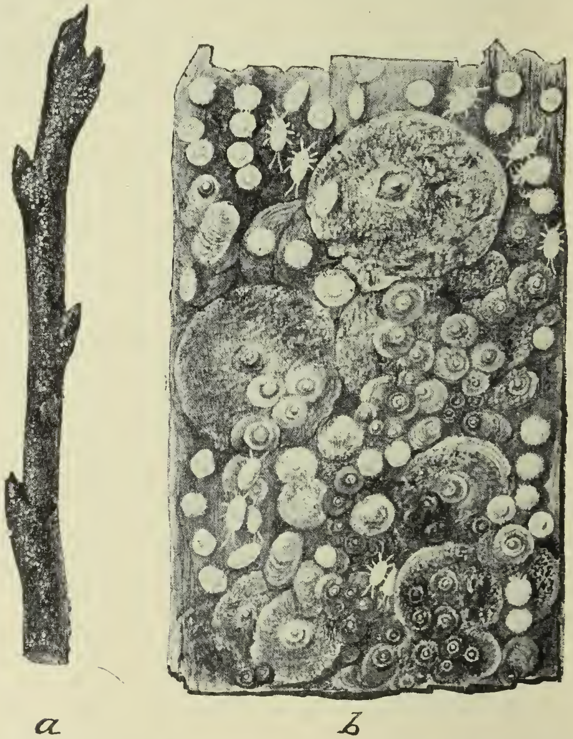

Figure 7.—Appearance of San Jose Scale on bark; *a*, infested twig, natural size; *b*, bark as it appears under hand lens, showing scales in various stages of development and young larvæ. (After Howard and Marlatt in Bulletin 3, n. s. Div. Ent. Dept. Agr.)

The nature of the attack varies considerably, and depends upon the kind of tree. Peach, in my experience and observations, is the most susceptible of all the fruit trees. It is a very rare occurrence in this state to find an infested peach tree that has withstood the attacks of this insect three years, and the size of the tree up to the age of five or six years has little to do with it. Trees six years old which have made a beautiful growth, succumb readily to this deadly enemy. An excellent illustration of this character can be seen by referring to figures 3 and 4. Where peach trees from four to six years old become encrusted with the scale, all the upper branches will be completely killed, and new growth will begin from the main trunk near the ground. Trees in this condition with the cluster of sprouts at the base, with leaves very much larger than the normal leaf, present a very characteristic appearance. The dead tops set in a bunch of green foliage, is very striking, and the cause of the condition can be inferred, as far as one can see the tree. In one peach orchard of 2,500 trees five and six years old, 1,300 were in this condition last fall. In another orchard, containing something over 28,000 peach trees, about 8,000 had this peculiar growth. This condition is, no doubt, due to the fact that the root system of larger trees is sufficient to maintain life in the lower part of the trunk, even after the top has been entirely killed. The young growth is usually pitted, and marked by the presence of the insects the first season, and rarely, if ever, lives through the second season. It is therefore, not an uncommon occurrence to find trees in an orchard entirely dead where this growth at the base was conspicuous the year previous.

Young peach trees from two to three years from the bud are not usually affected in this way. When attacked by the scale, they are killed out completely, there not being enough root system to sustain the growth at the base. I never have seen, and have not heard of an instance where a peach tree was killed by this scale in the nursery row. This is what we would expect, as the bud produces a marketable tree by one season's growth, and if the scale has been introduced on the bud, its presence would only be susceptible late in the season. The second and third years, therefore, in the life of a peach tree, if the scale was introduced when budded, are the important ones.

Pear, apple, plum, quince, cherry, apricot and nectarine are not so quickly killed as the peach, but all of them will finally succumb, if the scale is allowed to breed year after year uninterruptedly. Pear, Apple, plum and cherry will usually die the third or fourth year, providing the pest is upon the trees at the time they come from the nursery. I have seen cases where pear and apple have been killed in one year from the nursery, and it is not an infrequent occurrence to find dead pear, apple, plum, cherry, apricot and nectarine in a nursery row, where the scale has been established. The general appearance of badly infested trees is about the same in all cases, the scurfy, grayish or ashy coating being conspicuous.

If a pear tree is moderately infested, the scales are easily detected at the very tip of the new growth. They do not occur so conspicuously on the terminal growth of the apple and plum, as on the previous years's growth. The pest is seen on the leaves usually only on badly infested trees. On peach, it produces a reddish or purplish tinge on the leaf, especially where the insect is attached. There is at times, a yellowish spotting that follows the attack. As a rule, the great majority of the scales are attached to the upper surface of the leaf, and arranged along the mid rib and veins, and are mostly males. Pear and apple leaves are not so conspicuously marked as peach.

I have seen the scale only on the fruit of apple, pear and peach. Where there are only a few insects upon a pear or apple tree, their presence upon the fruit affords the easiest and simplest method of locating the infested trees. The bright reddish or purplish spots produced by the inects are very conspicuous, and can be seen with the naked eye long distances. On badly infested trees, the fruit becomes one mass of spots and scales; it is small, rough, and sometimes cracked open, as seen at figure 8. Such fruit is not fit for the market, as it is incipid, and should be avoided. The scale also colors the peach somewhat in a similar manner, but the spots are not, as a rule, so conspicuous, on account of the fuzzy surface. By cutting into an infested peach, it will be seen in some varieties that the purplish tinge extends to a depth sometimes of a quarter of an inch.

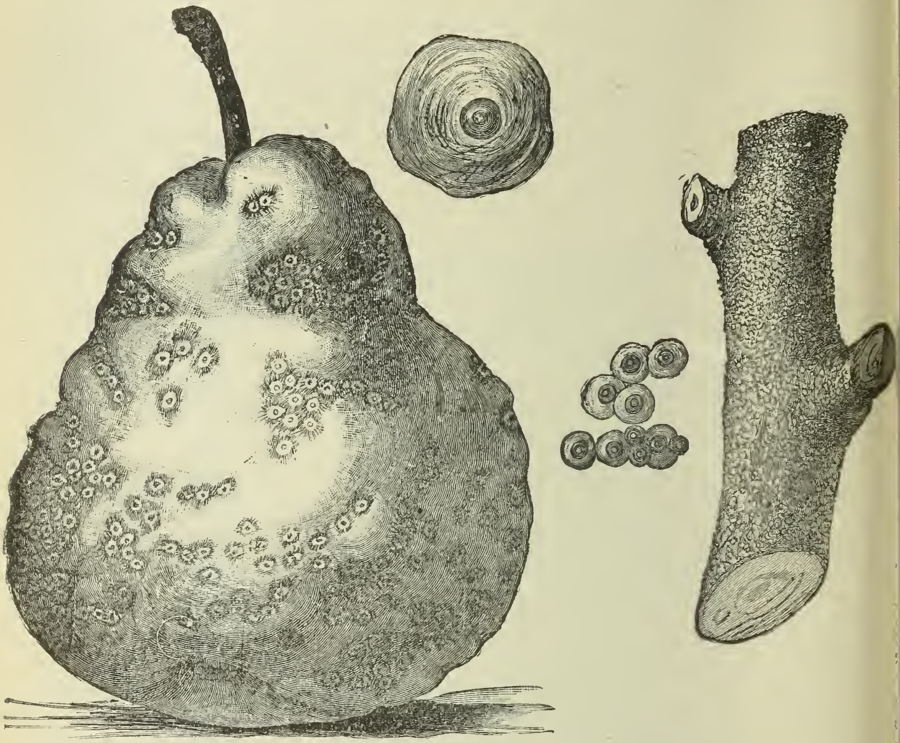

Figure 8.—San Jose scale on twig and pear, with enlarged male and female scales. (After Howard, Year-book Dept. Agr. 1894.)

I do not know that the scale has ever been found upon the roots of a tree in their normal position and covered. The inference is, that it cannot thrive below the surface of the ground where the earth is closely packed around the tree. It has been found below the surface around the trunk of young tress where there was more or less open space, caused by the swaying of the tree, or where burrows had been made by ants. In fact, it seems very probable that ants may have considerable to do with the establishment of this scale upon certain trees. Prof. Webster cites an instance of this nature in Entomological News (December, 1897), in which he says:

"For my own part, I have become exceedingly suspicious of the influence of ants scattering the San Jose scale, not only about the ground, but below the surface as well. We have one case in Ohio, where a young orchard was set out in 1893, and in the fall of 1895, an infested tree was found and cut off six to eight inches below the surface of the ground, and burned. In cultivating, dirt was thrown toward the place where the tree had stood, and in the meantime, a young shoot had started up from the old stump, and grown to a considerable height. This fall, this shoot was found to be badly infested with the scale, and only a few were on the trees next adjoining."

The conspicuous purplish spots produced by the scale on certain varieties of trees, are valuable characters, and aid the inspector very much. It cannot be inferred, however, that the insect observed, is the San Jose scale, simply because the purplish spots are present. The cherry scale, *Aspidiotus forbesi,* a species described by me from Illinois a few years ago, and Putnam's scale, *A. ancylus,* both produce markings of the same character; and it is not uncommon to find markings of a similar nature on pear, produced by the scurfy scale, *Chionaspis furfurus.*

FOOD PLANTS.

The San Jose scale has a very wide range of food plants, attacking practically all of our deciduous fruit trees, and many of the small fruits. It can also sustain itself upon many of our ornamental shrubs and native trees. In two instances, I have found it breeding during the summer months upon crab grass and milk weed, in the vicinity of infested trees.

The following list of food plants has been made up from original observations, and a careful review of all recently published articles on this subject. At present, we have recorded forty-six species of plants upon which the scale has been found, to say nothing of the large number of varieties embodied. For instance, under apple, I have observed the pest upon no less than 80 varieties during my inspection work in nurseries and orchards.

Of the orchard fruits infested, the peach, pear, apple, plum and cherry are most conspicuous in this state, but the quince, persimmon, Rocky Mountain dwarf cherry and flowering quince should be included.

The small fruits are currant, grape, raspberry, gooseberry, flowering currant, black currant and strawberry. The nuts are pecan, almond, chestnut, black walnut, Japan walnut, and English walnut. The miscellaneous trees, shrubs and other plants are linden, elm, acacia, alder, osage orange, sumac, weeping willow, English willow, golden willow, laurel leaved willow, catalpa, Lombardy poplar, Carolina poplar, golden leafed poplar, silver maple, cut-leaved birch, mountain ash, Japanese quince, Citrus trifoliata, Actinida, red dogwood, snow ball, June berry, Loquat, Laurel, Akebia, Vose spirea, Cotoneaster, hawthorn, euonymus, English huckelberry, milkweed and crab grass.

From this wide range of plants, it appears that the scale can accomodate itself under most any circumstances, and doubtless, other food plants will be discovered. There are certain groups, however, upon which it has not been found, the pines and cedars for example, appear to be exempt. There are certain varieties of fruits also that seem to be practically free from its attacks, as noted in this report. The Kieffer and Laconte pear, although standing along by the side of badly infested trees, were practically free. There was also another instance of this kind near Still Pond, Kent Co., where the infested trees were entirely surrounded by a block of Kieffer pears. The infested trees were all destroyed when the real character of the insect was discovered, but up to the present time, no scales have been found in the Kieffer orchard. Still another evidence of this character was found in the orchards of John I. Case, near Wheaton, Montgomery County. Here a number of Kieffer pears were planted in between badly infested peach trees, and in no instance, could more than a dozen scales, and these mostly males, be found after diligent searching. Howard and Marlatt cite a peculiar case of this nature in their Bulletin (No. 3, n. s., p. 38), in which they say: " A notable instance is the case of a tree which bore both Lawson and Kieffer grafts. The Lawson branch leaves and fruit were entirely covered, while the Kieffer portion was entirely free from the scale."

Prof. Webster has observed that the Early Richmond cherry was also practically immune. He says (Bul. 81, p. 212): "I have seen a case where the limbs of one of these cherry trees interlocked with those of a pear tree, that had been killed by the scale, yet the cherry was free. In another case, an early Richmond tree had been grafted into Mahaleb stock, and a shoot of the original stock had been thrown from out below the graft. This shoot was thickly populated with scale, while the tree itself was entirely free. I have never yet found it attacking Mulberry, even though trees were standing in the midst of dying trees, killed by this scale."

SUMMARY OF LIFE HISTORY.

The San Jose scale is one of a group of insects known as the armored scales, from the fact that they are protected by a shell or scale-like covering. The insect spends most of its life period under the scale. The only time it is capable of moving about is immediately after birth, and it crawls then only for a few hours. The adult male is also active a short time, as will be explained later.

The partially matured insects pass the winter under the scale. If, during this hibernating period, one of the scales is carefully turned with the point of a knife, a keen eye, without the aid of a magnifying glass, can detect a small, oval, wax-like mass about the size of the diameter of a pin. This is the real insect, although it has not the slightest resemblance to one. With the swelling of the buds, the young insects begin to take food and develop quite rapidly. The male scales begin to be quite prominent the latter part of April, the adult male insects appearing a few days later. The females reach maturity about the first week in June in this state, and begin to produce their young soon afterward.

The production of the young of the San Jose scale is quite different from that of most other insects. Instead of hatching from eggs, as is usually the case, the young are born alive, and the female is about six weeks producing her progeny. For this reason it has been very difficult to ascertain, with any degree of certainty, the exact number of broods, on account of the intermingling of generations, and, not until the appearance of Howard and Marlatt's Bulletin (No. 3), was the life history of the insect thoroughly and carefully elaborated. The observations were made by Theodore Pergande, an assistant in the Division of Entomology, U. S. Department of Agriculture, on potted plants in the department insectary.

The eggs are fairly well formed within the body of the female, and are enveloped in a very thin, delicate membrane, which is cast off at birth. The newly born insect remains motionless for a few minutes, until its delicate organs harden, so that it can move about. It then forces its way out from under the scale cover and crawls over the plant in search of a suitable place to attach itself.

When first born, the insects are extremely small, and can scarcely be detected by the naked eye. They are lemon yellow in color, with somewhat elongated, oval bodies, and only nine one-thousandths of an inch in length. The general appearance of the young creatures, looking at it from below, is shown in the illustration, figure 9. As indicated, it has six well, developed legs, two antennae or feelers, and a very long, thread-like beak or proboscis, through which it sucks the juice of the plant. After crawling a few hours, this lance-like beak is inserted into the plant tissues, and the young creature begins to exude from its back a mass of very fine, white, waxy filaments, and in about two days it is entirely covered with the external covering as shown at figure 10, *c. d.*

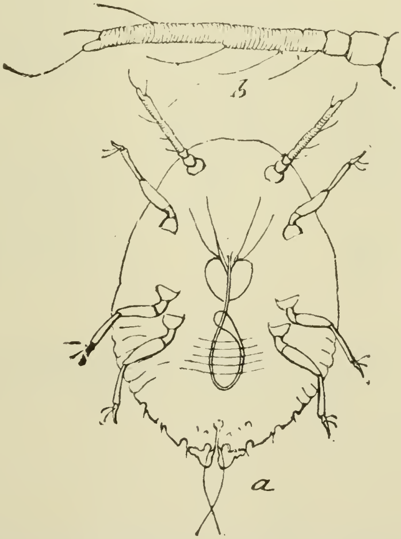

Figure 9. San Jose Scale; *a*, larva, greatly enlarged; *b*, antenna of same, still more enlarged. (After Howard, Circ. 3, New Series, Div. Ent., U. S. Dept. Agr.).

For the first twelve days after birth, one cannot distinguish the male from the female. At the expiration of this time, the molting begins, that is, the insects cast off their old skins, and the male can be distinguished by its size, being a little longer than the female, and the presence of eyes, the female having lost hers entirely.

About three weeks after birth, the male transforms to a true pupa, and from four to six days later, the adult emerges by backing out from under the scale. So far as we know, the males issue mainly at night. They are rather bold, peculiar looking insects, as shown at figure 11. They are rarely or never seen by the average observer, on account of their minuteness. They are only one-sixteenth of an inch in length. Their legs and antennae are quite large in proportion to the rest of the body. The body is of an orange color, while the wings are quite transparent, and of a silvery luster. It has no mouth, and therefore, takes no food, necessarily living a very short time, usually only a few hours. It is provided with a long, lance-like organ, known as the anal style, at the end of the body as shown in the illustration.

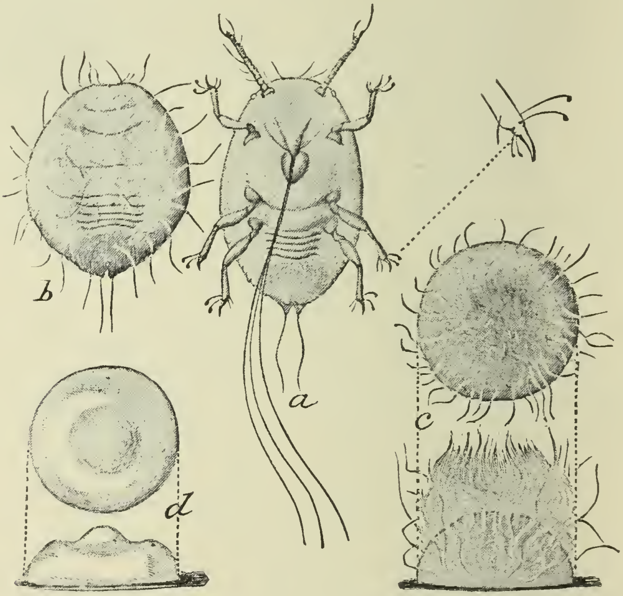

Figure 10.—Young larvæ and developing scale; *a*, ventral view of larvæ, showing sucking beak with setea separated, with enlarged tarsal claw at right; *b*, dorsal view of same, somewhat contracted, with the first waxy filaments appearing; *c*, dorsal and lateral views of same, still more contracted, illustrating further development of wax secretion; *d*, later stage of same, dorsal and lateral views, showing matting of wax secretions and first form of young scale—all greatly enlarged. (After Howard and Marlatt, Bull. 3, n. s. Div. Entom. Dept. Agr.)

About thirty days from birth, the female reaches maturity, and the embryonic young can be seen within her body. From three to five days later, the young begin to make their appearance. The adult female is a very curious looking creature, being about one-twenty-fourth of an inch in length, pale yellow in color, and is wingless, legless and even eyeless, as seen at figure 12. She is provided with a very thread-like organ, resembling a whip lash, as shown in the illustration. This is the mouth part through which the food is taken, by inserting it into the plant tissues. By turning a fully matured scale in mid-summer with a knife or some sharp pointed instrument, the female can be seen. It resembles a mere bit of yellowish wax more than it does a living insect.

The length of a generation is determined by the female, and usually covers a period of from thirty-three to forty days. Mr. Theodore Pergande, under the direction of Dr. Howard, carried successive generations on potted plants throughout the summer in Washington, and found there were four full generations with a partial fifth. By these careful observations, the fecundity of the females, as well as the number of generations, was determined. It was shown that the males predominated the first and second generations, but in the third and fourth, the females considerably outnumbered the males. It was estimated that the number of descendants from a single female during one season was 3,216,080,400. Is it any wonder that a tree succumbs very quickly when these insects are left to propagate undisturbed? We would not expect that all the individuals would survive and perform their function in life; but under favorable conditions, it is safe to assume that a very large percentage reach maturity.

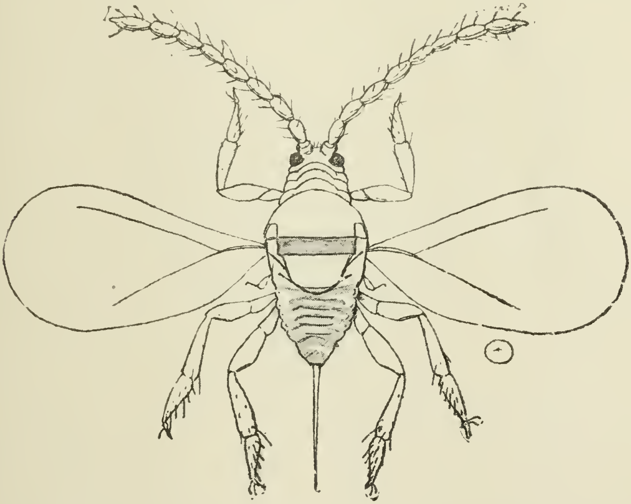

Figure 11.—San Jose scale, adult male, greatly enlarged. (After Howard, Circ. 3, Second Series, Div. Ent., U. Div. Agr.)

The young begin to appear in this latitude about the first week in June. The time, however, depending somewhat upon the weather conditions. In 1897 we observed the first young June 3; while in 1898 none appeared before June 11. The breading continues uninterrupted until checked by very cold weather. We have observed living young in Kent county under a scale with the parent insect, as late as December 19th.

It is not necessary in this place to give a detailed description of all the forms, as the foregoing remarks will suffice our purpose.

MEANS OF DISTRIBUTION.

The very nature of this insect is such, we must look to other agencies than itself for a general distribution. As already stated, the female is legless and wingless, and the young crawl only a very few hours, and even then they travel a comparatively short distance, before attaching themselves to the plant. The insect could only crawl from one tree to another where the limbs were interlocked, and such a condition rarely occurs in young orchards. In nurseries, however, there is no doubt but what the pest does spread by actually crawling from tree to tree.

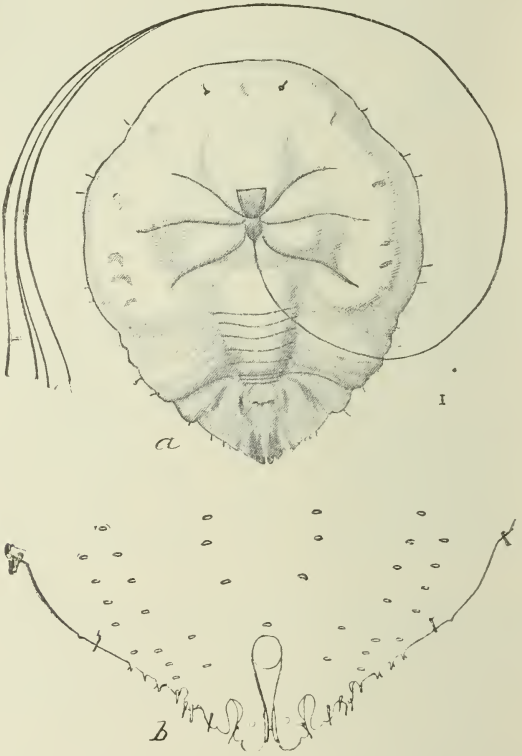

Figure 12.—San Jose Scale; *a* adult female, highly enlarged, ventral view showing sucking tubes; *b* anal plate, still enlarged. (After Howard & Marlatt, Bulletin 3, New Series, Div. Ent., U. S. Dept. Agr.)

In most instances, the pest is distributed on young trees, buds, grafts or scions, direct from the nursery. In this state, the infested trees in 57 orchards are directly traceable to the nurseries from which they came, as already stated. Once established, in an orchard, the spread is necessarily slow, but distribution is sure and gradual. The wind, in my opinion, is the greatest factor in carrying the young larvae from tree to tree. In one orchard near Sharpsburg, there is a noticeable instance of this kind, as stated in the detailed account of the outbreak in the various counties. Here the scale was first noticed on a few trees along the lower side of the orchard, and had spread up the side of the mountain, in the direction of the prevailing winds, infesting about 3,000 trees. Another case, of a similar nature, occurs in Frederick county, where the pest has gradually spread in an orchard of 2,500 trees. Still another instance, which strongly supports this view, was noted August 6th, 1897, in an orchard in Prince George county, where a milkweed growing midway between the trees was found badly infested with scale. Of course, there is a possibility that the scale may have been carried to this plant by either a bird or an insect, but the probabilities are slight.

To settle the question beyond all doubt, I made several experiments in two orchards which were badly infested, where the scale was breeding in great numbers, in August and September, 1897. In the first case, I selected a tree about ten feet high, and had a gentleman who was wearing a blue serge coat, stand about twelve feet from the trunk on the side toward which the wind was blowing. The wind was blowing a moderate breeze, and upon examination of the coat ten minutes later, I found many larvae crawling upon it. I had neglected to inspect the coat before we began the experiment, and therefore, the results were not definite, as we had been walking through the orchard, and the larvae may have been brushed from the trees. The experiment was repeated August 11th and September 9th, with definite results. In both instances, the larvae were blown from ten to fifteen feet, and lodged upon a piece of black cloth, which had been set up for that purpose. Close examination showed that many larvae were brushed off by the leaves and twigs as they scraped one against the other.

Birds also carry the scale sometimes long distances on their feet, legs and feathers. A notable case of this kind came under my observation March 15th, 1898, in an orchard in Howard county. I found a bird's nest in a tree about a third of a mile from a block of plum trees that was infested with scale. The twigs upon which the nest was resting were moderately infested with scale, and none were found on other parts of the tree or any of the surrounding trees. The natural inference was that the scale had been carried there by the bird when it returned after a visit to the infested trees. There are several instances of this kind upon record, and there is no doubt but what birds in an infested orchard are a great source of danger in spreading the scale.

Insects are also responsible for carrying the scale from place to place, especially the predaceous insects, or those that feed upon them. As noted in another place, a small, black ant was seen July 23rd, 1896, carrying one of these insects in its jaws. It is barely possible that ants carry these young larvae from plant to plant in certain cases, as already noted in this report.

The scale may also be carried accidentally by men and domestic animals. If, for instance, horses, cattle, sheep or hogs were allowed to graze in an orchard infested with scale, the chances are that they would brush against the infested trees, and transfer the pest to other trees.

Professor Rolfs cites a very interesting case that came under his observation in Florida. A gentleman who had some melons growing in an infested orchard, gave them to a friend, who took them away in a wagon. About a year later the scale appeared upon a tree under which the horses had been hitched while the melons had been unloaded. The inference naturally was that the young insects were carried to the tree on the wagon, harness, horses or melons, as there was no scale nearer than the point just mentioned, which was three miles away.

NATURAL ENEMIES.

Much has been said about the natural enemies of the San Jose scale, and I must say, a great deal of nonsense has been published by our agricultural and horticultural press on this subject, without due respect for the opinions of men who are devoting their entire time to the serious study of these reducing agents nature has provided. There is no question of a doubt that the introduction of the little Australian ladybug, *Vedalia cardinalis*, into California some years ago for the destruction of the cottony cushion scale, *Icerya purchasi*, was a signal triumph in economic entomology, and that it saved California her orange industry from inevitable ruin, but I am of the opinion it will be many a day before we see a similar repetition with any other insect. So far as the San Jose scale is concerned, we expect very little help in its destruction from its natural enemies.

TRUE PARASITES.

There are four species of true parasites known to feed upon the San Jose scale. Three of these have been bred in Maryland. One of them, *Anaphes gracilis*, How., having been reared from scale in no other state. It was bred by Dr. Howard from scales from Charles county. Two other species, *Aphelinus fuscipennis* How., and *Aphelinus mytilaspidis Le B.*, have been reared by myself from scales taken at the following places: Riverside, Annapolis Junction, Araby and Mitchellville. Thus

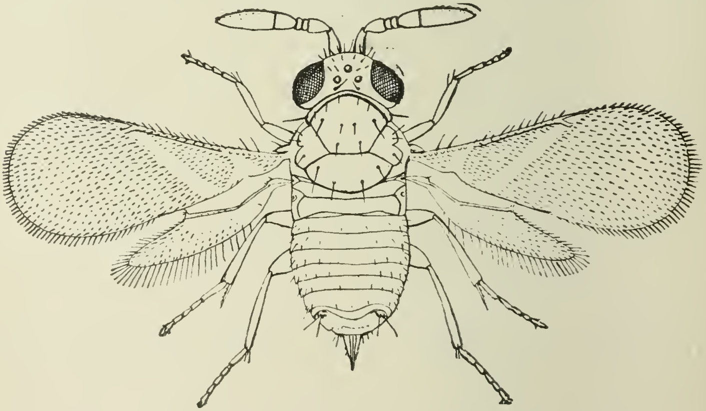

Figure 13. True Parasite, *Aphelinus diaspidis* Howard, of the San Jose Scale (After Howard in Bulletin 3, n. s. Div. Ent. Dept. Agr.)

it will be seen that three of the four parasites occur in Maryland. The other species, *Aspidiophagus citrinus* Craw., so far as I know, has been bred from the scale only in California and Florida.

These little friends are exceedingly small and are scarcely visible to the naked eye. *Aphelinus fuscipennis* measures only twenty-three thousandths of an inch in length, and has a wing expanse of fifty-one thousandths. A parasite greatly enlarged, belonging to this genus, is shown at figure 13, and will give a general idea of the appearance of these insects. We certainly cannot expect any immediate beneficial results from these parasites in this state. In all our efforts to secure them in our breeding cages, we have been obliged to enclose hundreds of thousands of scale to obtain one parasite. *Aphelinus fuscipennis* is no doubt, much more abundant in California than in eastern United States, but even there, partial extermination of the scale in certain orchards is seemingly due to a fungous disease, as pointed out by Howard and Marlatt.

PREDACEOUS INSECTS.

Of all insects which feed upon scales, the ladybugs are, perhaps, the most important. They are termed the predaceous enemies, and in this state, two species have been found feeding upon scale. The most efficient is a little, black creature about a sixteenth of an inch in length, known as *Pentilia misella,* and is shown at figure 14. It was first ob-

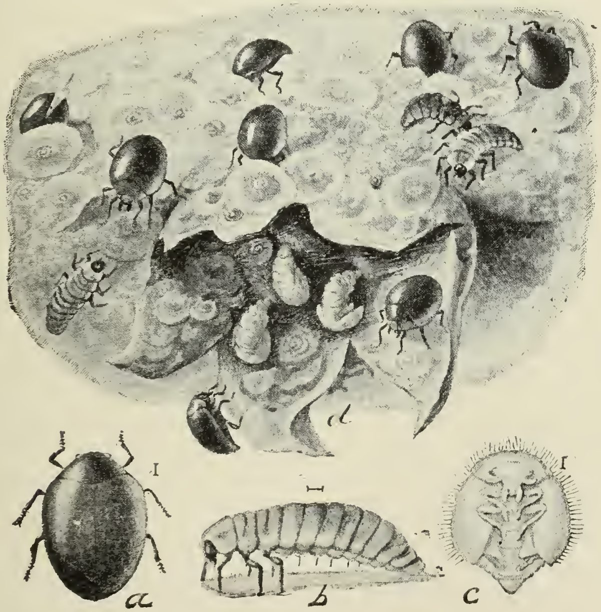

Figure 14. The minute, black Ladybug, *Pentilia misella;* *a*, beetle, *b* larva, *c*, pupa; *d*. blossom end of pear, showing scales with larvæ and pupæ of Pentilia, with the former feeding upon them, and the pupæ of Pentilia attached within the calyx—all greatly enlarged. (After Howard and Marlatt, Bull. 3, n. s. U. S. Dept. Agr. Div. Ent.)

served feeding on this scale by Mr. E. A. Schwartz, an assistant of Dr. Howard, at Charlottesville, Virginia. It is very common throughout this state in infested orchards. Both the larvae and adults feed upon the scales. The beetles prefer the mature females, but will feed ravenously upon all stages. I found the beetle very abundant in December, January and February at Annapolis Junction on plum trees that were badly infested with the scale. Thousands of them could be counted upon certain trees. I have also seen the same insect in almost every orchard in the state where the scale exists.

Another species known as the twice stabbed ladybug, *Chilocorus bivulnerus*, was observed feeding on the scale in several orchards. It was particularly abundant in the orchards at Araby and St. Margaret's. This beautiful jet black beetle and its young are shown in the illustration at figure 15.

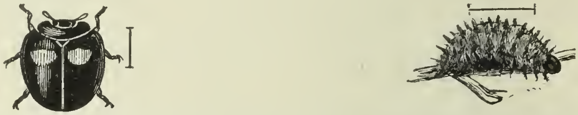

Figure 15. Twice Stabbed Ladybug, *Chilocorus bivulnerus* and its young; both enemies of the scale. (After Riley, 1st Mo. Rept.)

There are many people who believe that we should sit down, fold our hands, and let nature rid our orchards of the San Jose scale. It must be clearly understood that we have unbalanced nature to such an extent that we cannot expect to restore the equilibrium unless we assist nature ourselves.

Dr. Howard says (Bul. 3, p. 54): "Valuable as these natural enemies undoubtedly are, however, they will be efficient only at intervals, and there will always be considerable periods when, for some cause or another, they will be less numerous, and the scales will then have a chance to multiply. In fact, after the scale has become established, and the balance between it and its natural enemies has been reached, we may expect with more or less regularity periods of abundance and scarcity of the scale insects. The possible usefulness of parasites and predaceous insects, should, therefore, at least in the east, not be allowed for a moment to interfere with active operations with remedies, nor blind one to the importance of the San Jose scale, and the extraordinary precautions which would always be taken to prevent its wider dissemination."

In a bulletin (No. 12) by the same author, issued in March, 1898, he says: "In no case since the publication of bulletin No. 3, have any of the insect enemies of the scale been reported to have done any special good."

The State Horticultural Society of New Jersey, secured an appropriation of $1,000.00 in 1896 from the legislature for the purpose of importing into New Jersey certain ladybugs from California, which were said to be doing great good in reducing the scale. Dr. J. B. Smith, the State Entomologist, of New Jersey, was detailed to inspect the orchards in California, collect, and send colonies of the several species of ladybugs to New Jersey. Several colonies of various species were safely transported and liberated in infested New Jersey orchards. In regard to this introduction, Dr. Smith in his report for 1897, says: "Nothing has been seen in 1897 of the California Coccinellids introduced in 1896. Most of the places in New Jersey, in which they were introduced, were searched by myself on several occasions, but not a sign of the species has been noticed."

At the same time, Dr. Smith sent several colonies to Dr. Howard, in Washington, who reports that (Bull. 12); "No living specimens have been seen during 1897."

FUNGOUS DISEASES.

Like higher animals, insects are subject to the attacks of fungous diseases, and very often epidemics occur, which greatly reduce certain species.

The latter part of 1891, Mr. D. W. Coquillett, an assistant of the United States Department of Agricultural, then stationed in California, called attention (Bulletin No. 26, pp. 22-23) to a condition existing in an orchard near Pasedena, where he found the San Jose scale dead and dying from some unknown cause. As the orchard had not been treated with any insecticide, and no ladybugs and tree parasites were observed, he was of the opinion that this mortality was due to certain climatic influences, unless it could be shown to be due to some low form of fungus growth.

Prof. P. H. Rolfs, of the Florida Agricultural Experiment Station, who has given this subject considerable attention, has published the results of his observations and experiments in Bulletin No. 41, which appeared in August, 1897. He has found the parasite fungus, *Sphaerostilbe coccophila* occurring both on the San Jose scale and upon a common native species *Aspidiotus obscurus*. He has succeeded in cultivating the fungus on various materials in the laboratory, and has artificially inoculated trees infested with San Jose scale in orchards. There is some hope that this fungus can be used to good advantage from the economic standpoint in certain localities, but it is extremely doubtful, whether it can be successfully used in the northern states, as diseases of this kind are greatly influenced by climatic conditions. Entomologists of the north and west have already begun to test the disease, but so far, the results have not been very satisfactory. In January, 1898, I wrote Prof. Rolfs, requesting specimen twigs infested with the disease, to be used here for experimental purposes. A box containing specimen twigs infested with *Aspidiotus obscurus* and *A. perniciosus* was received January 13th. Twigs were tied in the branches of peach trees badly infested with San Jose scale in the vicinity of Frederick, but up to the present time, the disease has not spread from the original twigs.

February 25th, 1898, I received a lot of peach twigs infested with San Jose scale from Dorchester county, and upon examination, found that fully 95 per cent. of the insects were dead, from some unknown cause. The twigs had just been cut from the trees, and death could not have been due to the drying out of the soap. There were no external indications of the work of parasites or predaceous insects, and no fungus could be detected. I am of the opinion that death was due to some peculiar, local climatic condition, or to a bacterial disease.

HYDROCYANIC ACID GAS.

EARLY HISTORY.

Hydrocyanic acid gas has been used as an insecticide a comparatively short time. Its destructive properties to insect life were discovered by W. D. Coquillett, an assistant of the Division of Entomology, United States Department of Agriculture in 1886, while experimenting upon the cottony cushion scale, *Icerya purchasi* in orange orchards near Los Angeles, California.

In addition to the detailed account of the gas treatment given by Mr. Coquillett, in the report of the Department of Agriculture for 1887, and in Insect Life, Vol. 3, pages 457 to 460, by way of explanation, he wrote me March 21st, 1898, as follows:

"During the summer of 1886, I was employed by the United States Department of Agriculture to carry on a series of experiments at Los Angeles, California, against *Icerya purchasi*, but owing to an insufficient appropriation, I was laid off on the first of August of that year. As no perfect remedy had at that date been discovered, I determined to experiment with gases in a private capacity, and at my own expense. Accordingly, during the first week of the following month I began experimenting with hydrocyanic acid gas, which I thought would be the best for the purpose, owing to its very poisonous qualities, the rapidity of its generation and the readiness with which it diffuses itself in the air. Nobody suggested to me to try the gas. It was not until the following July that the Department of Agriculture again placed me on its rolls."

This series of experiments demonstrated the following facts, as recorded in Insect Life:

(1). That when the aqueous solution of cyanide was used, the trees were more liable to be injured by an overdose of the gas than when the cyanide was used dry.

(2). That trees treated in the hottest part of the day were more liable to be injured by an overdose of the gas than if treated in the earlier portion of the day or at night.

(3). That the use of a black tent in the day-time somewhat prevented injury to the trees by the gas, but only a comparatively slight degree.

Mr. Coquillett continued his experiments in 1887, using a tent constructed out of bed ticking and oiled with linseed oil. At this time he found, that by passing the gas through sulphuric acid, it was less liable to injure the trees. In 1888, other experiments were conducted for the purpose of testing the different brands of potassium cyanide; but it was not until 1889 that the process was finally perfected. Mr. Coquillett found by using the cyanide dry, along with two parts of water to one of sulphuric acid, and doing away with the device for circulating the gas in the tent, he got better results, and at the same time not so expensive. After Mr. Coquillett had perfected the equipment and found that the most satisfactory results were obtained at night, he gave his formula to some friends, who tried the method, and then applied for a patent on the gas treatment, which was finally granted in January, 1891, even

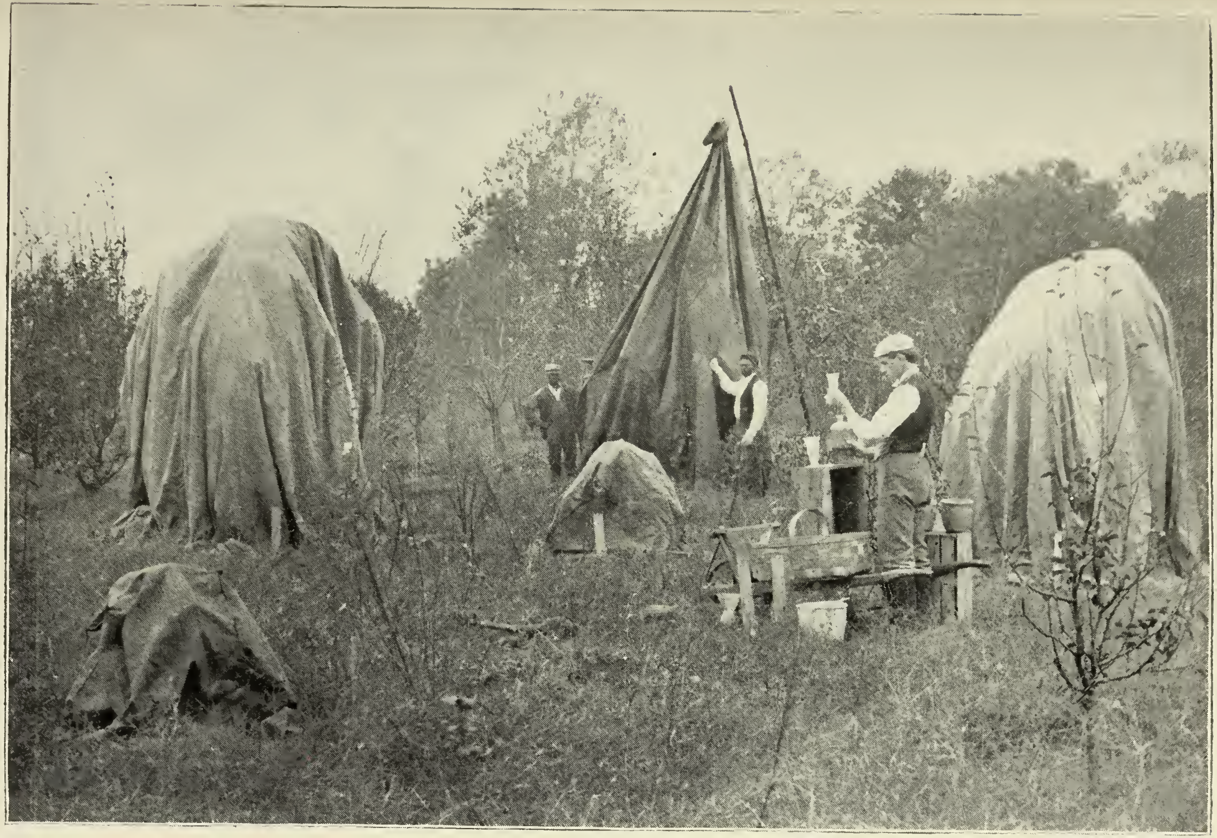

Figure 16.—Experimenting with Hydrocyanic Acid Gas in a block of 2500 Bartlett Pear Trees infested with San Jose Scale. Photo. taken October 16, 1897, by W. G. Johnson.

after the strongest protest on the part of Mr. Coquillett and Dr. Riley. The gas has been successfully applied in the orange orchards of this county for the destruction of scale insects since that time.

USE IN GREENHOUSES.

Professor Albert F. Woods, now Acting Chief of the Division of Vegetable Pathology, U. S. Department of Agriculture, conducted the first successful experiments with hydrocyanic acid gas in greenhouses in 1894. At that time he fumigated a large greenhouse filled with ferns, infested with scale insects, killing all the creatures without the slightest injury to the youngest growing fronds. His next experiment was in a house containing about 20,000 coleus plants, many varieties, badly infested with the white-tail mealy bug, *Orthesia insignis*. All the insects were killed without injury to the plants, much to the satisfaction of the owner, as he had exhausted every resource for their destruction, and was about to abandon the house.

Professor Woods and Mr. P. H. Dorsett, an assistant of the division, have since conducted many experiments, testing the effect of the gas upon various varieties of plants, and in the summer of 1897, made the most extensive application of gas ever made under cover. The houses fumigated contained 70,000 cubic feet of space, and about 10,000 violet plants badly infested with a black Aphis or plant louse were fumigated. This experiment was satisfactory in every respect, and the plants were completely rid of the pest.

The advantages of this gas in greenhouse work are summarized by Mr. Dorsett, in the Florists' Exchange for October 9th, 1897, as follows:

1. The effectiveness with which it acts.
2. Its rapid fusibility.
3. Ease of application.
4. It does not weaken the tissues of the plants when properly applied, but the method of using it has to be determined in each case.
5. It leaves no objectionable odor in the house; flowers such as violets, being as sweet immediately after its use as before.
6. A decrease in the number of applications necessary during the season.
7. Its use in ridding imported or exported stock of insect pests.

For clearing greenhouses of insect pests, slugs, etc., there is no remedy so satisfactory as hydrocyanic acid gas. It is easy to apply and inexpensive.

OPERATIONS IN MARYLAND.

From what I had seen of this method in California in orange orchards, I felt certain that it could be applied equally as effective to our deciduous fruit trees in the east, if properly handled. In the spring of 1897, I began a series of experiments upon young pear, apple, plum and nectarine, as recorded under experiments Nos. 1 to 7. The results of these experiments were so very satisfactory, I was prompted to continue my work on bearing trees in the fall of 1897.

*Equipment:**—Through the generosity of Capt. Robt. S. Emory, of Chestertown, I was able to complete my equipment for this experiment. Personally, Capt. Emory has done more, perhaps, than other individual in the east or south, for the control and destruction of the San Jose scale. At his own expense, he furnished me eight tents, two others being purchased by the experiment station, and two were kindly loaned us by Dr. L. O. Howard. With this equipment of twelve tents, I was prepared to begin the largest series of experiments ever undertaken in orchards east of California.

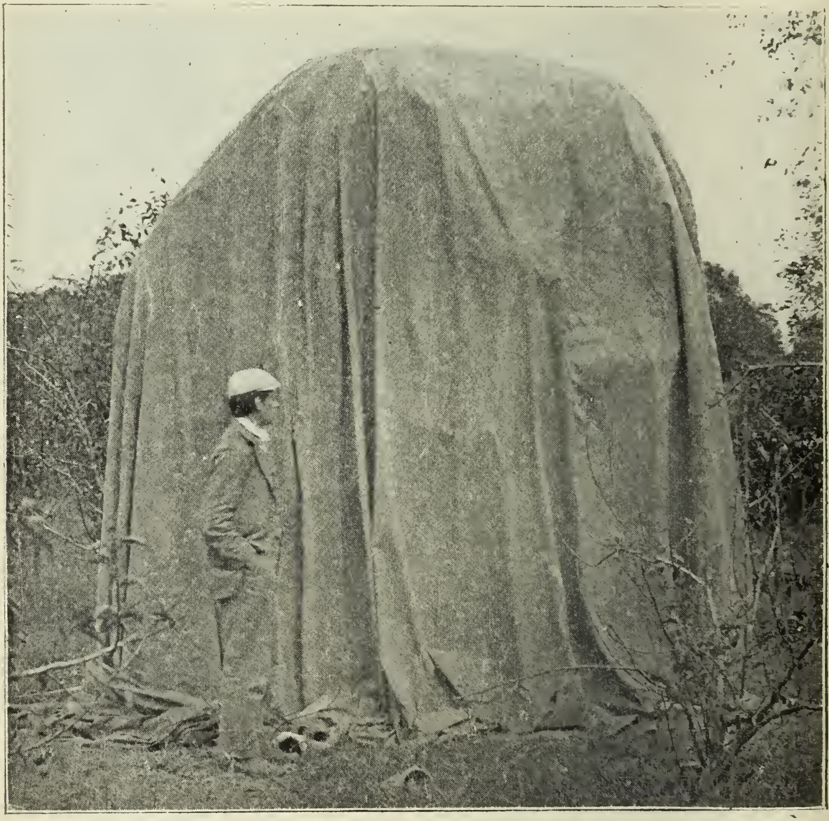

Figure 17.—A thirty-foot Sheet Tent covering a sixteen-foot tree. Photo. taken November 6, 1897, by W. G. Johnson.

Tents:—Our tents were of two forms, one was an octagonal sheet, modeled after those used by the U. S. Department of Agriculture, called a "sheet tent," and the other was what we term a "box tent," made according to a design by Capt. Emory. A thirty-foot sheet tent, covering a sixteen-foot pear tree is shown in the illustration at figure 17, and a fifteen-foot box tent, covering a twelve-foot tree, is illustrated at figure

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*The photographs of our equipment used in the Report of the Entomologist of the New Jersey Experiment Station for 1897, Figs. 12, 13 and 14 were reproduced and inserted without permission from this office.

18. Our sheet tents are of various sizes; one was forty-five feet in diameter, used only for very large trees, one thirty feet, and five twenty-five feet. The box tents also vary in size; two being fifteen feet square at the bottom, ten feet square at the top and fifteen feet high; two others have a seven-foot base, four-foot top and were ten feet high; still another which we call the "baby tent," has a four-foot base, two-foot top and is five feet high.

All the tents were made of eight ounce cotton duck, such as is used for making light sails. With a little care, any awning or tent maker can cut the sheets, so there is practically no waste in the material. They are cut and made into quadrants and then put together. The center in the large tents, for about two feet in diameter, is double, as there is considerable strain upon the material. A half-inch or five-eighths rope is hemmed in around the edges of both sheet and box tents.

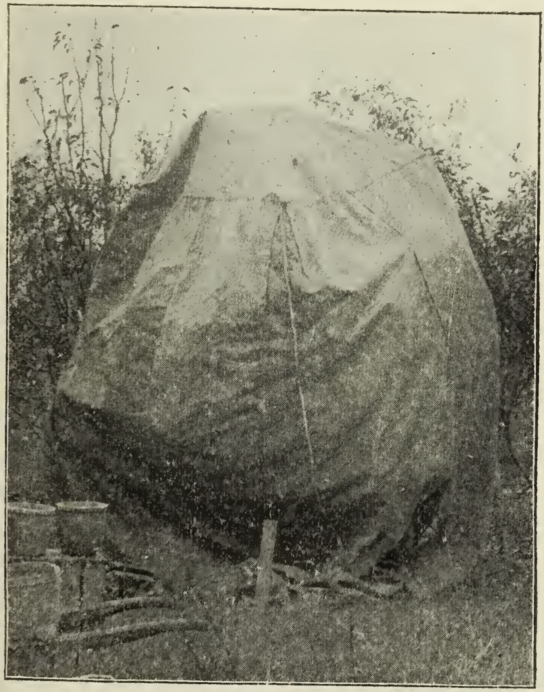

Figure 18.—A Box Tent in position covering a twelve-foot tree.
Photo. taken November, 6, 1897, by W. G. Johnson.

I have found that the tents are much more easily handled by not putting gas pipe or anything stiff or heavy around the bottom, as is customary in some places.

The cost of the tent, of course, varies according to the size, and the cost of oiling must be added. All of our tents are thoroughly oiled by painting them with boiled linseed oil. The following quotations, which includes oiling, were secured in Baltimore, September, 1897:

Box tent	4x5x2	$4.00
Box tent	7x10x4	7.00
Box tent	10x15x15	12.50
Sheet tent	25 feet diameter	18.00
Sheet tent	30 feet diameter	25.00
Sheet tent	45 feet diameter	42.50

On the whole, the sheet tents are more easily handled than the box tents. The 7x10x4 box tent is very convenient for trees varying in size from four to eight feet, and I prefer it to the sheet for trees of the same size. The "baby tent" is of no practical account, as trees under four feet should not be covered with a tent at all, a barrel or box being much better for that purpose, as I will explain later on. The large box tent

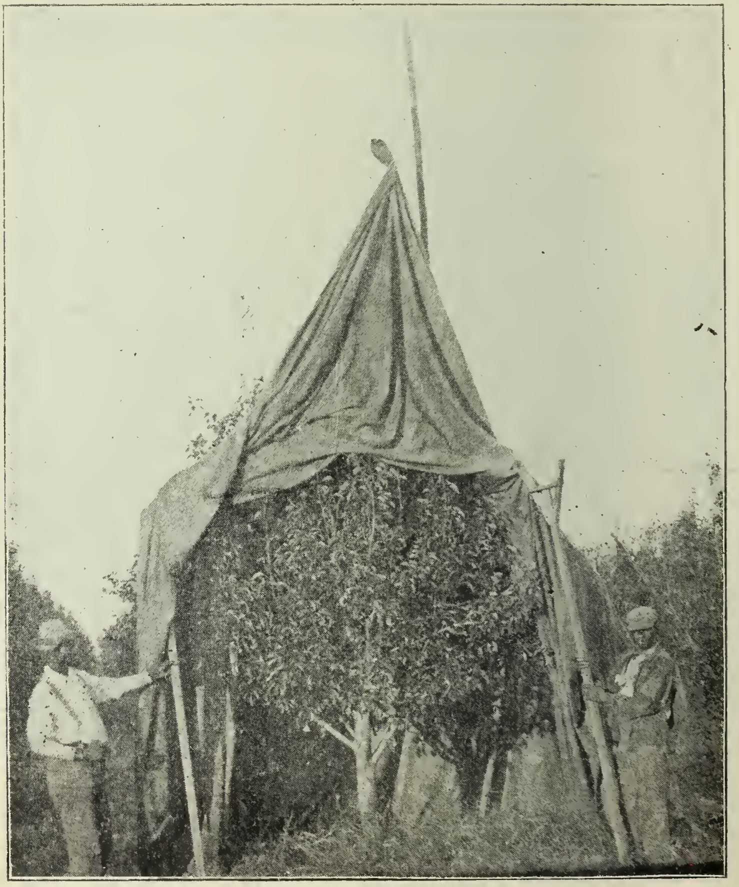

Figure 19.—Method of removing a tent. Photo. November 6, 1897, by W. G. Johnson.

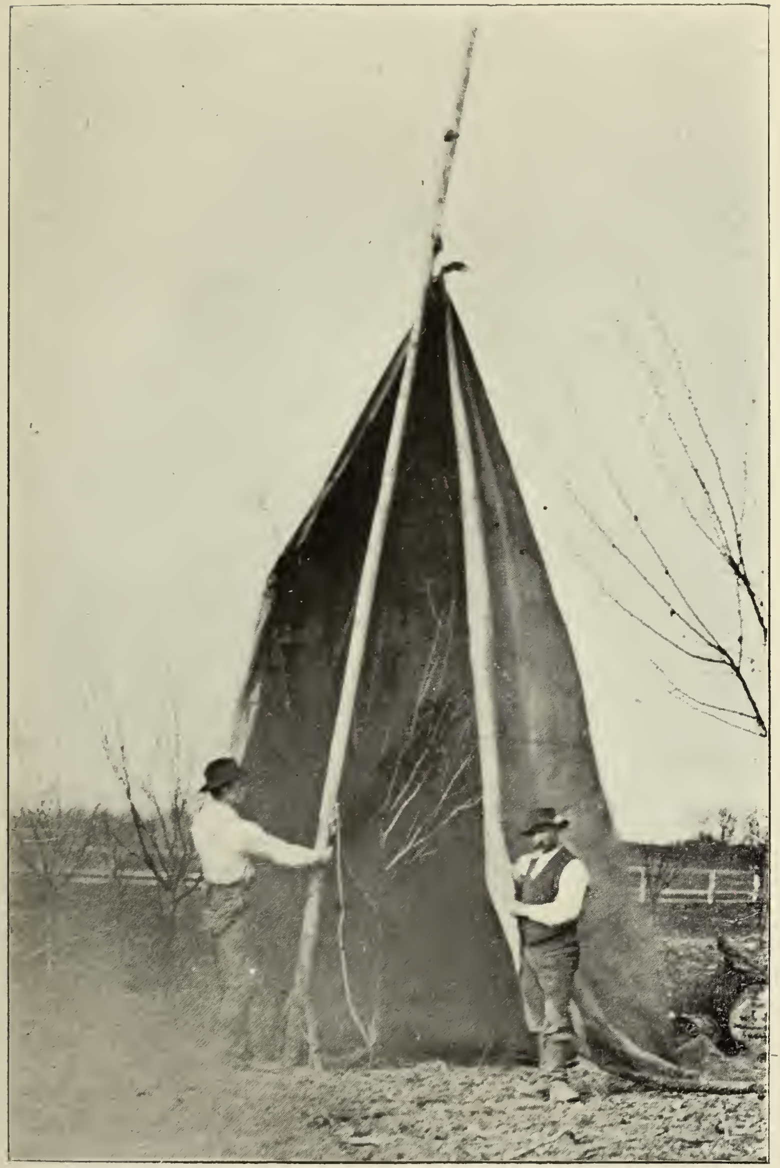

Figure 20.—Placing a tent in position over a plum tree. Photo. taken March 17, 1898, by W. G. Johnson.

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is too cumbersome, and requires greater care and more time to tent and untent a tree with it than with the twenty-five foot sheet.

Lifter:—We used a single pole in our work for tenting and untenting a tree. The pole is known as the "lifter," and consists of an eighteen-foot yellow pine sapling, thoroughly seasoned, such as is used on small sail boats, about four inches in diameter at the base, tapering to about three inches at the top. It is strong, light and very durable. A piece of 3x4 inch scantling is nailed at the base and braced as shown in the illustration at figure 20. A small, block pulley, large enough to carry a five-eighths inch rope, is screwed near the top of the lifter. In my work, I use from forty to fifty feet of half or five-eighths inch rope in the pulley which is called the "pulley rope." About the height of one's shoulder is screwed a "Y," around which the rope is fastened when the tent is hoisted. Another piece of rope from twenty-five to thirty feet in length, is tied near the top of lifter above the pulley, and is called the "stay rope." It is by means of this rope that the lifter is kept in place, by tying the end to an adjacent tree as illustrated.

We use a small hand pole for assisting in untenting a tree, so as to keep the weight of the tent from the twigs. This is known as the "helper" and is shown at figure 19.

Chemicals:—The chemicals used are (1) Cyanide of Potassium, (2) Sulphuric acid and (3) water. The cyanide must be practically chemically pure, guaranteed 98-99 per cent. It can be bought for about 30 cents per pound in bulk. The prices quoted me by the manufacturers* vary from thirty to thirty-two cents per pound in bulk of 100 pound lots and from 32½ to 35 cents in smaller quantities, and are subject to advance without notice.

I find that cyanide broken into lumps about the size of shell bark hickory nuts give better results and is more satisfactory to handle than large lumps. It can be procured in small lumps by notifying the manufacturer.

The best grade of commercial sulphuric acid, (sp. gr. 1.83) should be used. A grade used ordinarily in the manufacture of fertilizer (chamber acid) will not do. I secured an excellent grade from the manufacturers** at 1½ cents per pound by the carboy. This substance is also subject to advance in price.

Water from any ordinary well or cistern will suffice, the only requisite being that it should be clean.

Other materials:—There are several other materials needed for the work. (1) I find that pickle jars, holding from two to four quarts are the best adapted for the chemicals, for the generation of the gas. There should be at least as many jars as there are tents in operation; (2) A cheap, flat basket about eighteen inches or two feet long and a foot wide with partitions made of thin boards dividing it into about six or eight compartments, is necessary for carrying the cyanide; (3) A liberal supply of small paper bags holding about a pint or a little less. The cyanide is weighed out into the various amounts needed, placed in the bags and carried in the basket. *Caution:* Care should be taken not to weigh too much cyanide at a time as the bags become saturated with moisture when the cyanide is long exposed to the air, and they are hard to handle. It is policy to weigh the material at night or early in the morning, or during the noon hour, and when not in use in the orchard, the bags should be kept in an airtight can. (4) A graduated glass beaker, holding at least, eight ounces, for measuring the acid and water; (5) A bottle with glass stopper, holding about two quarts for acid; (6) A pail for water; (7) A tin cup for dipping water; (8) A wheelbarrow and a small wooden box upon which the utensils can be kept, and (9) as many small pieces of boards, with smooth surface, about two feet long by two or three inches wide, with one end sharpened, as there are tents. These are used for recording time during fumigation and are stuck into the ground near the tent. The entire outfit at work is shown in the illustration at figure 16.

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*Alonzo L. Thomsen, M'f'g. Chemist, Baltimore, Md., and Roessler & Hasslacher Chemical Co., 100 William Street, New York.

**John J. Thomsen's Sons, Baltimore, Md.

Tenting a Tree:—The lifter is set at an angle of about sixty degrees, and the stay rope fastened to an adjoining tree, thus holding it in place. One end of the pulley rope is then passed around the tree and tied to the tent lying on the ground on the opposite side. The operator at the lifter then draws the tent to the pulley and fastens the rope. He then steps back a few feet and taking the stay rope pulls the lifter towards himself until the center of the tent is about over the top of the tree. In the meantime, the other assistant brings the sides of the tent around toward the lifter and the operator takes one side while the assistant holds the other, as shown in the illustration at figure 20. When the lifter is at the proper angle to bring the center of the tent over the top of the tree, one side of the tent is then passed to the assistant between the lifter and the tree; while the operator loosens his pulley rope and lets the tent fall in position. The assistant unties the stay and pulley ropes and carries the lifter to the next tree; while the operator "banks" the tent; that is, he folds it in around the base of the tree and tramps it down or throws a few shovels full of earth around it as may be required. If the wind is blowing, and the tent is a little slack, a few pieces of stone or chunks of wood may be required. This done, every thing is in readiness for the chemicals.

When the trees are uniform in size, as many rows are taken as there are tents. The sheets tents are then transferred from tree to tree by simply reversing them over and over again. The method varies from the foregoing only in that the pulley rope is carried around to the side opposite the lifter, and fastened to the bottom of the tent covering the tree. The lifter is also set at a more acute angle. The box tents cannot be reversed in this manner, and must in each instance, be taken from the tree, lowered and again hoisted. The method of untenting a tree is shown at figure 19.

Caution:—Care should be taken in handling the tent so as not to break the branches and fruit spurs. The weight of the tent should be lifted by means of the helpers, as shown in the illustration. On very large trees two lifters are necessary, and in this way the weight of the tent is kept from the tree until it is ready to be lowered.

Placing Chemicals:—As soon as the tent drops over the tree, the expert estimates the capacity and measures the acid and water. He places the acid in the jar, and carries the water in the beaker. He then raises up one side of the tent, puts the jar in place, pours in the water, tears the top from the bag and drops cyanide, bag and all into the jar, closing down the tent as soon as possible. He then marks upon the time board when the tent is to be removed.

Caution:—The acid should never be carried in the beaker, as there is danger of getting it upon the tent. It is also well to dip one's hands into water occasionally to wash off any acid which would otherwise make finger marks on the tent. The jar should always be placed upon a level surface, as near the trunk of the tree as possible, and see that the tent is not folded in near it, as the acid sometimes spatters as the gas is generating. After a tent is removed, care should be taken where the residue in the jar is thrown, otherwise a tent will be dragged through it and ruined. My plan is to empty the jar where it stands.

Estimating Amounts:—An expert soon becomes so proficient he can estimate the height and diameter of a tented tree at a glance, and by referring to his table of amounts, measures the acid and water without delay.

I have found some little difficulty in estimating the cubic contents of a tented tree. The figure is neither a cylinder nor a sphere, but lies between the two. In the preparation of the following table, I have based my calculations on the height and diameter of the tented tree. First, I calculated the cubic contents of a cylinder whose height and diameter were the height and diameter of the tree, then calculated the contents of a sphere whose diameter was the height of the tree. Then by taking half the difference and adding it to the contents of the cylinder, I found my estimation was approximately correct.

I have found in my experimental work that 0.20 of a gram of Potassium Cyanide per cubic foot of space enclosed, gave me the most satisfactory results upon scale infested, deciduous trees. The following table of amounts is calculated according to this standard. The amount of acid used is always one-half more than the cyanide, and the water is a half more than the acid. For instance, if I use 1 ounce (by weight) of cyanide, there will be 1½ ounces (liquid measure) of acid and 2¼ ounces of water.

TABLE OF AMOUNTS.

HEIGHT OF TREE.	DIAMETER.	CYANIDE.	ACID.	WATER.
Feet.		Grams.	Ounces.	Ounces.
4	3	6.17	0.32	0.48
5	4	12.82	0.67	1.00
6	4	18.85	1.00	1.50
7	4	26.75	1.41	2.11
		Ounces.		
7	5	1.11	1.66	2.49
8	4	1.30	1.95	2.92
8	5	1.50	2.25	3 39
9	5	1.96	2.94	4.41
9	6	2.24	3.36	5.00
10	7	3.20	4.80	7.20
10	8	3.62	5.43	8.14
11	7	3.95	5.92	8.88
11	8	4.40	6.60	9.90
12	9	5.88	8.82	13.23
12	10	6 51	9.76	14.64
13	9	6.93	10.39	15.58
13	10	7.65	11.47	17.20
14	11	9.76	14.64	21.96
14	12	10.65	15.97	23.45
15	11	13 28	19.42	29.88
15	12	14.24	21.36	32.04
16	14	16.34	24.51	36.76
16	15	17.53	26.27	39.43
17	14	18.39	27.57	41.35
17	15	19 36	29.40	44.23
18	15	22.06	33.09	49.63
19	16	26 10	39.15	58.72
20	16	29.00	43.50	65.25

EXPERIMENTAL OPERATIONS.

In the fall of 1896, I discovered a lot of badly infested trees of various varieties in young orchards and nurseries, and decided to make a thorough test of the hydrocyanic acid gas treatment. Accordingly, the trees were selected for the work, and the experiments begun in March, 1897. The outcome of these tests show:

(1). That young trees, either from the nursery or orchard, can be fumigated without injury to the tree.

(2). That the San Jose scale can be completely destroyed, the only requisites necessary being a good, tight room, box or tent, constructed for the purpose, and the chemicals.

Young Trees:—The following experiments were made upon young trees direct from the nursery or from young orchards of one year's standing. All the trees in these experiments were treated in a fumigatorium, especially constructed for that purpose. The room was 4x7x7½ feet.

No. 1—Four Angouleme pear trees, literally covered with San Jose scale, discovered in one year old orchard November 18th, 1896, were taken up and fumigated March 22d, 1898, for thirty minutes with two ounces cyanide, three ounces acid, and four and one-half ounces water. Planted near my house April 3rd. Made excellent growth during the summer, and not a living scale has yet been discovered upon them. Examination made once a week. Old scales most all washed off. Pits and scars still present. April 1st, 1898, trees making beautiful growth and no live scale.

No. 2—Three Lawrence pear from a nursery, treated same day and planted under same conditions as No. 1. Trees were very badly infested with scale. Examined every week during the summer and fall of 1897, and not a living scale has yet been detected. Trees made a beautiful growth.

No. 3—Six Garber pear trees from young orchard, originally from a southern nursery, treated like Nos. 1 and 2, and at the same time. Trees planted April 4th, 1897, and watched closely throughout the summer and fall. Not a living scale found. Trees also critically examined in January, 1898, when the foliage was off, but no live scale could be found, and most of the old scales had become detached, leaving the bark pitted and marked.

No. 4—Two Clapp's Favorite pear trees from the nursery row treated at the same time and like the three preceding. Trees planted April 4th, 1898. These trees were also moderately infested with scale. Results same as the foregoing.

No. 5—Two Abundance plum trees from a young orchard of one year's standing, very badly infested, treated as the above. Planted April 5th, 1897. Both made excellent growth and no living scale has yet been discovered on them.

No. 6—Four Ben Davis apple trees, two from a one year old orchard and two from a nursery. Treated as above April 5th, 1897. Planted April 7th. Those from the orchard were very badly infested, the trunks and larger branches being literally encrusted with scale. No living scale found any time during the summer or winter months. Trees made good growth.

No. 7—Consisted of miscellaneous lot of nursery stock as follows: 2 Wheatland peach; 4 Oldenburg and 3 Winesap apple; 2 Early Purple cherry; 2 Burbank, 1 Ogon and 4 Satsuma plum; 2 Standwick nectarine and 1 Prunus pissardi. All these varieties were badly infested with scale, and were fumigated together for thirty-five minutes, September 24th, 1897. The amount of gas generated was the same as in the preceding. All these trees were set out and watched carefully, and not a single living scale has yet been discovered.

St. Margarets:—A series of experiments were begun at this place March 4th, 1898, upon peach trees one year from the nursery, which were badly infested with the San Jose scale. The trees were grown by the owner, A. A. Stinchcomb, as already cited on page 21. The object of the experiment was to ascertain whether or not an ordinary room in a frame building with lath and plaster could be used successfully for fumigating purposes. The building was a small, frame structure, 16 feet square, divided into two rooms, each 7¾ feet wide, 15¼ feet long and 7¼ feet high. The room selected contained two windows, and one door opening into the other room. The floor was tight, but to prevent any escape of gas, it was covered to a depth of about two inches around the edges with loose earth, which was packed close to the mop-board. The cracks in the windows were also stopped up with paper. The trees were divided into two lots of about 1,000 each, the first of which was fumigated March 4th, from 11.50 a. m. to 12.30 p. m.; and the second, March 5th, from 3.52 p. m. to 4.32 p. m. Each lot remained in the house forty minutes as indicated. The amount of potassium cyanide was a little larger than ordinarily used. The chemicals were as follows: cyanide, 8 ounces; acid, 12 ounces and water, 18 ounces.

The trees were then removed, and planted again in the orchard. They have made a good start this spring, and so far as can be ascertained at present, May15th, there are no living insects. 14 trees from this lot were brought to the experiment station, and set out for observation. They were all very badly infested, but not a living insect has been found to June 1st. The trees are all alive and growing fairly well, considering the weather. Six trees from this lot not fumigated were planted as a check upon the others. May 15th the scales were alive, but no young had appeared. Young were found crawling on all the trees June 13th. They were removed and burned June 14th, for fear that the young would get on the other trees. At this time no young or living insects could be found on the fumigated trees.

Bearing Trees:—The results of the foregoing experiments were so gratifying, that I decided to continue my work on a more extended plan on bearing trees, and with the equipment already described, I began my observations.

I started out to determine the following points:

(1)—The physiological effect of the gas upon the tree;

(2)—The effect of the gas upon the San Jose scale; and

(3)—The practical utility of using this method in the east and south during all kinds of weather conditions in large bearing orchards.

To determine the first two points, many preliminary experiments were necessary, and when these were finished, the third point was taken up and continued from October 16th to November 27th, 1897.

The orchard chosen for these operations belongs to Capt. R. S. Emory, and contains about 2,500 nine year old Dwarf Bartlett pear trees, which had become infested with the scale from an adjoining young Lawson pear orchard. All the trees were in excellent condition and full of foliage. The scales were breeding and active, and taking it all in all, the conditions could not have been more favorable for my experiments. The preliminary tests were begun September 27th, 1897, continued at all hours of the day, and at night, and were finished October 1st.

Chestertown:—A list of these experiments is given herewith simply as a matter of record. The trees selected for the purpose varied in size from five to ten feet, were full of foliage and in excellent condition, as noted above.

No. 1—Tented at 8.48 a. m., removed at 9.18 a. m.; height of tree five feet; temperature 66 degrees; time thirty minutes; cyanide $\frac{1}{2}$ oz.; acid $1\frac{1}{2}$ ozs.; water $3\frac{1}{4}$ ozs. Foliage not hurt.

No. 2—Time 9.03 to 9.33 a. m.; height five feet; temperature 66 degrees; time thirty minutes; chemicals same as No. 1, foliage slightly singed.

No. 3—Time 9.18 to 9.48 a. m. Repetition of No. 2, except that foliage was slightly more singed.

No. 4.—Time 9.32 to 10.02 a. m., same as above, except temperature, which was 67 degrees. Foliage singed.

No. 5—Time 9.35 to 10.18 a. m., same as above.

No. 6—Time 9.55 to 10.25 a. m., same as above. Temperature 67.5 degrees, foliage quite badly singed.

No. 7—Time 10.32 to 11.02 a. m., same as above.

No. 8—Time 11.00 to 11.30 a. m., same as above Temperature 69.6 degrees. Foliage very badly singed.

No. 9—Time 11.10 to 11.40 a. m., same as above.

No. 10—Time 11.30 to 12.00 a. m., same as above. Temperature 70 degrees

No. 11—Time 11.37 a. m. to 12.13 p. m., same as above. This was immediately followed by a second dose of the same amount from 12.13 to 12.43 p. m., or in other words, the tree was given the same treatment as the others double time. Temperature 70 degrees. Foliage very badly singed. This treatment did not injure the leaf or fruit buds in the least. The trees at the present time (May) is full of foliage and set full of fruit.

No. 12—Time 11.40 a. m. to 12.20 p. m. Height of tree same as above. Temperature 70.5 degrees. Chemicals used same as in all the preceding experiments, except No. 11. Foliage badly singed.

No. 13—Time 12.06 to 12.36 p. m., same as above.

No. 14—Time 1.05 to 1.35 p. m. Height of tree seven feet. Temperature 70.5. Cyanide 1 oz.; acid 1½ ozs.; water 2¼. Foliage badly singed.

No. 15—Time 1.16 to 1.46 p. m. Height five feet. Temperature 70.5 degrees. Foliage badly singed.

No. 16—Time 1.16 to 1.46 p. m. Height five feet. Temperature 70.5. Foliage badly singed.

No. 17—Time 1.47 to 2.17 p. m. Height nine feet. Temperature 70.5 degrees. Cyanide 2½, acid 3¾ and water 5¼ ozs. Foliage badly singed.

No. 18—Time 1.43 to 2.21 p. m. Height six feet. Temperature 70.5. Cyanide ¾ oz.; acid 1¼ ozs.; and water 2 ozs. Foliage badly singed.

No. 19—Time 2.15 to 2.45 p. m. Height five feet. Temperature 70. 5. Other conditions same as for other five foot trees. Foliage badly singed.

No. 20—Time 2.20 to 2.50 p. m. Height six feet. Temperature 70.5 degrees. Cyanide ¾ oz.; acid ¼ oz.; water 2 oz. Foliage badly singed.

No. 21—Time 3.00 to 3.30 p. m. Height six feet. Temperature 70 degrees. Conditions same as No. 20. Effect same.

No. 22—Time 3.12 to 3.42 p. m. Height five feet. Temperature 68 degrees. Conditions same as above for five foot trees.

No. 23—Time 3.12 to 3.42 p. m. Height five feet. Temperature 68 degrees. Other conditions same as No. 22, except that foliage not so badly singed.

No. 24—Time 3.36 to 4.06 p. m. Height six feet. Temperature 66.5 degrees. Cyanide $\frac{3}{4}$; acid $1\frac{1}{4}$ ozs.; water 2 ozs. Foliage not much injured.

No. 25—Time 3.42 to 4.18 p. m. Height five feet. Temperature $66\frac{1}{2}$ degrees. Chemicals same as above. Foliage slightly affected.

No. 26—Time 3.40 to 4.18 p. m. Height five feet. Temperature and conditions same as above.

No. 27—Time 4.15 to 4.45 p. m. Height six feet. Temperature 66 degrees. Foliage very little hurt.

No. 28—Time 4.30 to 5.00 p. m. Height five feet. Results same as above.

No. 29—Time 4.30 to 5.00 p. m. Height five feet. Results same as above.

No. 30—Time 4.55 to 5.25 p. m. Height six feet. Temperature 65.5 degrees. Foliage hurt very little.

No. 31—Date September 28th. Time 8.23 to 9.03 a. m. Height six feet. Temperature varied from 59 to 68 degrees. Time 40 minutes. Foliage slightly injured.

No. 32—Time 8.40 to 9.10 a. m. Height five feet. Foliage slightly damaged.

No. 33—Time 9.15 to 9.55. 40 minutes. Height five feet. Temperature 68. Results same as above.

No. 34—Time 9.45 to 10.15 a. m. Height five feet. Results same as above.

No. 35—Time 9.45 to 10.15. Height five feet. Results same as above.

No. 36—Time 10.05 to 10.35 a. m. Height five feet. Results same as above.

No. 37—Time 10.25 to 10.55. Height five feet. Foliage considerably damaged.

No. 38—Time 10.25 to 10.55. Height five feet. Results same as above.

No. 39—Time 10.40 to 11.20 a. m. Height six feet. Temperature 68 degrees. Foliage quite brown.

No. 40—Time 11.00 to 11.30 a. m. Height five feet. Results same as above.

No. 41—Time 11.00 to 11.30 a. m. Height five feet. Results same as above.

No. 42—Time 11.15 to 11.45 a. m. Height six feet. Foliage very badly singed.

No. 43—Time 11.32 a. m. to 12.02 p. m. Height five feet. Leaves very brown. Temperature 70 degrees.

No. 44.—Time 11.32 a. m. to 12.02 p. m. Results same as above.

No. 45—This tree was covered with one of the old tents from the United States Department of Agriculture. Time 2.21 to 2.56 p. m. Height ten feet. Temperature 70 degrees. Cyanide 4 ozs.; acid 6 ozs.;

water 9 ozs. Although this tree was fumigated in the heat of the day, not a leaf on the tree was affected. We, therefore, suspected that the tents did not hold the gas properly and after several other preliminary tests, we found that our suspicion was well grounded, as the tent had been in use for some time, and the oil had been quite well worked out of it. Two days later, quite a large percentage of the insects upon the tree were found still living. This tree was again fumigated October 16th with one of the new tents, this time using the same amount of chemicals as formerly. The foliage after this treatment became very brown, and we were unable to find any living insects.

No. 46—Time 2.23 to 2.53 p. m. Height of tree eight feet. Temperature 70 degrees. Cyanide 2 ozs.; acid 3 ozs.; water 4½ ozs. This experiment was a duplicate of the one preceding (No. 45), and the results obtained were similar. The trees was again fumigated October 16th.

No. 47—September 29th. Time 1.48 to 2.18 p. m. Height eight feet. Temperature 70 degrees. Cyanide 1¾ ozs.; acid 2½ ozs.; water 3¾ ozs. Foliage badly singed.

No. 48—Time 2.28 to 2.58 p. m. Height eight feet. Temperature 70 degrees. Cyanide 2 ozs.; acid 3 ozs.; water 4½ ozs. Leaves very badly singed. Petioles black almost to the base.

The two experiments immediately preceding were made to test the effect of a very strong dose of gas during the heat of the day. The amount of cyanide was about double the quantity ordinarily used, and the tests were made to see the effect upon the foliage, the leaf and fruit buds this spring. Both trees put out their foliage at the ordinary time, and the amount of fruit is as much as on any of the adjoining trees. Although this may be considered a double treatment, not even the buds on the most tender growth were affected. The leaves, however, on both trees were very brown, in fact, almost black within five minutes after the tents were removed. We were of the opinion that if the gas treatment affected the development of the fruit and leaf buds upon any trees in this orchard, it would certainly show itself in these tests, but we cannot at the present time (May), see any difference between these trees and those treated with smaller amounts, except that there is very little fruit set.

No. 49—September 30th. Time 2.33 to 3.02 p. m. Height eight feet. Temperature 77 degrees. Cyanide 1 oz.; acid 1½ ozs.; water 2¼ ozs. Foliage quite brown.

No. 50—Time 3.15 to 3.45 p. m. Height eight feet. Temperature 77 degrees. Cyanide ¾ oz.; acid 1¼ ozs.; water 2 ozs. Foliage slightly singed.

The two preceding experiments were performed in order that they may be brought in comparison with Nos. 47 and 48. The effect of the gas upon Nos. 49 and 50 was not so distinctly marked, very few fruit buds being hurt. as upon the two preceding, when fully 95 per cent. of the fruit buds were destroyed.

The two experiments which follow were made with the view of comparing the effects of day treatment with trees fumigated at night. I was especially desirous to see the effect upon the foliage as well as the dormant leaf and fruit buds.

No. 51—September 30th. Time 7.09 to 7.39 p. m., very dark. Height eight feet. Temperature 60 degrees. Cyanide $1\frac{3}{4}$ ozs.; acid $2\frac{1}{2}$ ozs.; water $2\frac{3}{4}$ ozs.

No. 52—Time 7.47 to 8.17 p. m. Height eight feet. Temperature 58 degrees. Cyanide 1 oz.; acid $1\frac{1}{2}$ ozs.; water $2\frac{1}{4}$ ozs.

The foliage on these trees was not injured in the least, so far as indications presented themselves during the next five days. The trees retained their leaves in good condition, but noticed one peculiarity in that they became yellowish and dropped a day or two sooner than those on trees immediately surrounding, which had not been fumigated. There was no singing or brown effect whatever, and the foliage seemed to be normal in every respect. The results obtained from these experiments compared with Nos. 47 and 49, in which similar amounts of gas were generated during the heat of the day, are very striking. In the day experiments, the leaves were very badly singed, while those fumigated at night were not hurt at all. At the same time, so far as the fruit and leaf buds were concerned, the former were nearly all killed by the day, while none were injured by the night treatment.

No. 53—October 1st. Time 11.21 to 11.51 a. m. Height ten feet. Temperature 75 degrees. Cyanide $3\frac{1}{2}$ ozs.; acid $5\frac{3}{4}$ ozs.; water $8\frac{1}{2}$ ozs. The foliage in this instance was badly singed, but the fruit and leaf buds were not injured in the least.

These tests show conclusively (1) that the gas is most injurious to foliage during sun-shiny days, late in the fall, between 9 a. m. and 4 p. m. In every instance where trees were treated between these hours, the foliage was singed. In several instances, it was perfectly brown, looking much like the effects resulting from a heavy frost. One important point was noted, however, that the leaf petioles were blackened about two-thirds their length, the base being perfectly green, and, therefore, the leaves fell readily a few weeks later. Another point that should be noted in this place, is the fact that the function of the foliage had been performed, consequently, we used the gas much stronger than we would have done at any other season when the trees were in full foliage.

(2.) That the dormant leaf and fruit buds, on the trees treated with gas sufficient to turn the leaves brown in the fall, are not injured.

(3.) That leaves which have been singed by the gas fall readily and do not remain clinging to the tree.

(4.) That trees treated in the morning before 9 a. m., and in the afternoon after 4 p. m., have the foliage very little affected by the gas.

(5.) That trees treated at night with very strong doses of gas do not have the foliage or dormant leaf and fruit buds affected at all, even where double the amount of gas ordinarily used is generated.

(6.) That the San Jose scale is entirely destroyed by the gas when used on calm, dry, sunny or cloudy days.

(7.) That the cost of treatment, aside from the equipment, is less than the whale oil soap.

Having completed these preliminary tests, we were so gratified with the results, we decided to have a field meeting for the purpose of having those who were especially interested in this matter present with us in order that they might examine and see our equipment in operation. Accordingly, an invitation was sent out at the request of Capt. Emory, and the following gentlemen responded and were present at the meeting October 15th, 1897: Dr. A. F. Woods, Acting Chief of the Division of Vegetable Pathology, U. S. Department of Agriculture; Prof. G. Harold Powell, Entomologist and Horticulturalist, of the Delaware Experiment Station; Dr. J. B. Smith, State Entomologist, of New Jersey; Dr. A. T. Neale, Director of the Delaware Agricultural Experiment Station; Dr. J. J. Black, a prominent and successful grower of New Castle, Delaware; Wesley Webb, Secretary, of the Peninsular Horticultural Society, of Dover, Delaware; Senator Charles T. Wescott; Dr. C. P. Gilpin; Mr. C. C. Hopper, Editor Transcript; Edward W. Emory; Dr. W. Frank Hines; W. S. Walker; Wilbur Eliason; and C. S. Hill, of Chestertown and vicinity.

In the evening, Capt. Emory served his guests a sumptuous dinner, and several toasts were responded to, and all were unanimous in the opinion that the experiment was complete in every respect.

Weather Conditions:—This experiment was prosecuted during all kinds of weather. We had sunshiny, cloudy and foggy days; rain, sleet and snow; windy and calm weather. The following abstracts from our daily diary will give a fair idea of the conditions under which we worked:

October 16th—Clear and calm. Temperature 90 degrees at 2 p. m. Foliage much burned.

October 17th—Sunday, sunny. Temperature 74 degrees at 3 p. m.

October 18th—Clear and calm. Temperature 76 degrees at 2 p. m. Foliage burned.

October 19th—Cloudy. Temperature 68 degrees. Foliage not hurt.

October 20th—Rain and wind. Temperature 54 degrees; rain stopped about noon. Windy, tree quite wet. No trees treated until after 2 p. m. Conditions unfavorable; too windy. Foliage not hurt.

October 21st—Cloudy and damp. Trees wet. Temperature 58 degrees at 8 a. m. Began work at 7.30, and tented trees and had gas generating in 30 minutes. Temperature 66 degrees at noon. Had good day, treated 114 trees. No foliage hurt.

October 22nd—Cloudy and misty; worked until 10.30 a. m., when it began to rain; temperature 60 degrees. Rained until 2 p. m. Trees too wet to work.

October 23rd—Cloudy, windy and misty. Temperature 54 degrees. Rain began 9 a. m., and had to stop work at 9.30; rain all day.

October 24th—Sunday; cloudy, windy and rainy.

October 25th—Raining and very windy and blustery. Temperature 53 degrees at noon; could not work.

October 26th—Cloudy and gentle breeze. Temperature 54 degrees. Good day for work. Treated 100 trees, and stopped work at 5 p. m. No foliage hurt.

October 27th—Cloudy, little wind and no rain. Temperature at noon 55 degrees. No foliage hurt.

October 29th—Rain last night and this morning; began work at 10 a. m.; trees quite wet. Temperature at noon 58 degrees. No foliage hurt.

October 30th—Cloudy, with sun coming out occasionally. Temperature 76 degrees 2 p. m. Foliage hurt when trees were tented during sunshine.

October 31st—Sunday; cold and disagreeable.

November 1st—Rain and blustery; too wet to work. Temperature 58 degrees.

November 2nd—Cloudy, sun shining occasionally. Election day. No work, as laborers were not here.

November 3rd—Cloudy, sun shining occasionally. Temperature 56 degrees. Foliage hurt on some trees.

November 4th—Sun shining part of the time. Temperature 60 degrees. Few trees with foliage singed.

November 5th—Cloudy and sunny. Temperature 62 degrees; work suspended, acid gave out.

November 6th—Clear, a light breeze. Temperature 76 degrees—2 p. m. Foliage hurt on most trees; 120 trees treated.

November 7th—Sunday; fair a. m., rain p. m. Temperature 52 degrees at 2 p. m.

November 8th—Rain and wind. Temperature 56 degrees at noon; began work at 3 p. m., and treated 11 trees and had to stop on account of rain. No foliage hurt, but fear that the gas has not killed all the scales, as the trees were very wet.

November 9th—Rain last night; cloudy during morning, and trees very wet. Temperature 70 degrees 2 p. m. Very windy, and could not handle tents; only 6 trees treated.

November 10th—Cloudy, some wind and cold. Temperature 48 degrees at 10 a. m. Very little work done on account of wind.

November 11th—Cloudy and windy during a. m.; rain during p. m. Temperature 52 degrees, could do nothing during afternoon.

November 12th—Cloudy, cold and very windy. Temperature 48 degrees 10 a. m., could not handle tents at all, too much wind.

November 13th—Cloudy, cold and windy. Temperature 41 degrees at noon; work very slow on account of wind.

November 14th—Sunday; cloudy, cold and windy. Temperature 43 degrees at 10 a. m.

November 15th—Rain last night. Trees very wet this a. m. Temperature 55 degrees at 10 a. m.; began work at about 9 a. m. No foliage hurt.

November 16th—Clear, slight wind. Temperature 56 degrees noon. Some foliage hurt, not much left on trees.

November 17th—Clear, little wind. Temperature 40 degrees at 10 a. m. Foliage slightly singed.

November 18th—Fair, gentle breeze. Temperature 43 degrees 11 a. m.

November 19th—Clear, gentle breeze. Temperature 40 degrees 2 p. m.

November 20th—Clear, but not able to work on account of lack of cyanide, which has been delayed on road.

November 21st—Sunday; clear and cold.

November 22nd—Clear and windy. Temperature 48 degrees at 2 p. m.

November 23rd Cloudy, cold and windy; some snow. Temperature 40 degrees 9 a. m. Could not use tents on account of wind until afternoon.

November 24th—Cloudy, with occasional sunshine. Temperature 40 degrees 9 a. m. Rather cold to work, and little windy; hard to keep tents in place.

November 25th—Clear, cold and cloudy. Temperature 40 degrees 9 a. m. Finished the Bartlett orchard and began the peach in p. m.

November 26th—Rained all the forenoon, cloudy in p. m. Temperature 70 degrees 2 p. m. Continued work on peach trees.

November 27th—Cloudy, sun shining occasionally, and quite windy. Temperature 60 degrees noon, tents weighted down, and left on only 25 minutes. Work completed at 2 p. m.

Annapolis Junction:—I began a series of experiments in a young plum orchard belonging to Col. W. S. Powell, Annapolis Junction, March 17th, 1898. The trees were just coming into bearing and 63 out of 108 were found infested with the scale, many of them being in a very bad condition (See page 36). The buds were just beginning to unfold and the worst infested trees were selected for experimental purposes, and numbered as follows: (Nos. 1 to 4 were sprayed with kerosene and gasoline.):

No. 5. March 17th. Abundance plum 9 feet in height; cloudy and rather windy. Temperature 62 degrees. Time 1 hour, 4 to 5 p. m. Cyande 5 ounces; acid 7½ ounces and water 10 ounces.

No. 6. March 18th. Abundance plum 7 feet in height; cloudy, strong breeze. Temperature 66 degrees. Time 45 minutes, 10.20 to 11.05 a. m. Chemicals 2½-4-6.

No. 7. Identical with No. 6, except time of application, which was from 10.25 to 11.10 a. m. Chemicals 4-6-9.

No. 8. Botankio plum 9 feet in height: cloudy, strong breeze, temperature 68 degrees. Time 45 minutes, 10.35 to 11.15 a. m.

No. 9. Botankio plum 10 feet in height: cloudy, gentle breeze, temperature 68 degrees. Time 1 hour, 11 a. m. to 12 noon. Chemicals 6-9-12½.

No. 10. Botankio plum 8 feet in height; other conditions same as No. 9. Time 1 hour 11 a. m. to 12 noon. Chemicals 3½-5½-8.

No. 11. Abundance plum 8 feet in height; weather conditions same as above. Time 1¼ hours, 11.45 a. m. to 1 p. m. Chemicals 3½-5½-8.

No. 12. Identical with No. 11, except amount of chemicals, 2-3-4½.

No. 13. Botankio plum 9 feet in height; weather conditions same as above. Time 1 hour. 12.10 to 1.10 p. m. Chemicals 2½-3½-5.

No. 14. Botankio plum 10 feet in height; cloudy; temperature 70 degrees. Time 1 hour, 12.15 to 1.15 p. m. Chemicals 4-6-9.

No. 15. Botankio plum 8 feet in height; weather conditions same as above. Time 45 minutes, 2 to 2.45 p. m. Chemicals 3-4½-6½.

No. 16. Abundance plum 7 feet in height; time 45 minutes, 2.05 to 2.50 p. m. Chemicals 3½-5½-8.

No. 17. Abundance plum 9 feet in height; cloudy, calm; temperature 68 degrees. Time 45 minutes, 2.10 to 2.55 p. m. Chemicals 3½-5½-8.

No. 18. Botankio plum 9 feet in height. Conditions same as No. 17. Time 45 minutes, 2.15 to 3 p.m. Chemicals 3-4½-6½.

These trees were closely followed during the spring, and all of them put out their foliage beautifully. April 1st, all the scales examined were dead. April 15th, no live scale found yet; May 1st, no live scale detected after turning 500 on twigs cut from each tree; May 10th, examination made by my assistant, Mr. Sanderson, but no live scale found; May 14th, I examined twigs cut from Nos. 5, 6, 7, 8 and 12, turning 500 scales on each, but found none living. May 26th, I examined twigs cut from Nos. 5, 6, 8, 12 and 16, but found no live insects, while living scales were found on twigs from the trees treated with pure gasoline. Young larvae were also found on these two trees June 14th.

The general outcome of these experiments up to the present time, June 15th, is so far satisfactory. We cannot hope to find a remedy for the San Jose scale that is more efficient than hydrocyanic acid gas. The trees have not been injured in the least, while those treated with kerosene have been seriously damaged.

Euonymus Scale:—The following experiments were made upon Euonymus bushes, *Euonymus americana*, which were very badly infested with *Chionaspis euonymi*, one of the scale insects, very troublesome to these shrubs in the south. The bushes were very old, some of them being 12 feet in height, with a diameter of from 6 to 8 feet. The scale began to make its appearance upon them about six years ago, so far as I can find out, and has been spreading gradually from year to year until every shrub on the place of this variety was infested. Seven of the most beautiful bushes have been killed, and the others so badly infested, it was impossible to see the bark.

The methods used were the same as those in the preceding experiments. It was warm, calm and rather cloudy. All the shrubs and hedge were treated December 16th, 1897.

No. 1. Shrub 10 feet high tented. Used 1¼ ozs. cyanide, 1¾ ozs. acid and 3 ozs. water. Time 30 minutes, foliage not hurt.

No. 2. A duplicate of No. 1, except shrub was 8 feet high.

No. 3. Same as No. 2.

No. 4. Same as Nos. 2 and 3.

No. 5. Very large shrub, tented 9 feet. 2½ ozs. cyanide, 3¾ ozs. acid and 5½ ozs. water. Time 45 minutes.

No. 6. Same size shrub as No. 5; same amount chemicals. Time 40 minutes.

No. 7. These shrubs were about 7 to 8 feet high and very dense, forming a hedge about 30 feet in length. It was very difficult to separate the shrubs, so as to get the tents in place. The chemicals used were roughly estimated, as we had no convenient method of estimating the contents tented.

I examined twigs cut form each of these experiments January 15th, 1898, and was unable to find any living insects. Twigs cut June 4th, 1898, forwarded to me by mail, were examined carefully under a lense, but no trace of living scale could be found on Nos. 1 to 6, inclusive. On No. 7, I found several females and they were alive. This is what I expected, as the conditions under which this hedge was treated, were of such a nature, we were not sure that all the twigs and branches came under the tent. My assistant, Mr. Sanderson, examined the shrubs June 7th, and was unable to find any living scale. The twigs examined by myself, June 8th, were literally encrusted with this scale, but all were dead, except an occasional one on No. 7. It must be noted also that not a leaf was injured on these shrubs by the gas.

From these results, it appears tha Euonymus shrubs infested with Euonymus scale, can be successfully treated with hydrocyanic acid gas without injury to the shrubs, and the complete destruction of the insects.

FUMIGATING NURSERY STOCK.

Owing to the widespread distribution of the San Jose scale, and the demand from fruit growers for a "clean bill of health," many nurserymen are now fumigating with hydrocyanic acid gas everything they grow or handle. Indeed, this is the only safeguard, and affords both the nurseryman and fruit grower a protection not secured in any other way. Fumigation has now become a necessity, and many of our most successful nurserymen have constructed houses for that purpose. There is no longer any doubt about the certainty of this method for the destruction of scale insects, and many other insects that infest nursery stock. In the fall of 1896, I fumigated a miscellaneous lot of trees, direct from the nursery, and badly infested with San Jose scale. These were then set out and watched carefully during the season of 1897, and up to the present time (May 1, 1898), not a living scale has been detected upon any of them. Other experiments were conducted in the spring and summer of 1897, with the most gratifying results. I have had a most excellent opportunity of making a thorough and conclusive test, and after two year's experiments I have concluded that the gas method is the only practical one for nurserymen and dealers. At the same time, it is the least expensive of any of the methods now known, and the generation of the gas is so simple it can be handled by any nurseryman. The only requisites necessary for its successful application are (1), a good, tight tent, box, or house and (2), the chemicals.

Necessary Equipment:—A good tent such as described on page 74. (Figures 17. 18), can be used; but I do not advise it, as the cost would be equal to or in excess of a house of much greater capacity. There are also other objections to a tent; the first is that by constant use it is liable to become torn, and secondly, and most important, the cubic capacity or space enclosed will vary with each lot of stock fumigated, unless a frame is used, and here lies the greatest source of error, as the chemicals, each time, must be weighed, after the calculation of the cubic contents. This danger of error is eliminated when a box or house is used, for it matters not whether one or a thousand trees are placed in the enclosure, the amount of the chemicals to be used remains constant.

The Box:—The size of the box or building to be used, of course, depends upon the amount of nursery stock grown or handled. For my experimental work I have found a box 6 feet long, 3 feet wide, and 2½ feet deep very satisfactory. It is made of common flooring and is double. Inside the boards run the long way, while outside they run cross-wise, which adds strength and stability. It is a simple, plain, open box, and when filled with young trees, kept in place by a couple of slats, it is turned bottom upwards and a little loose earth stamped about the edges. This makes a perfectly gas-proof box, and is all that is necessary for a nurseryman or dealer having a small trade.

Fumigatorium:—A fumigatorium is a house or room constructed or adapted for the fumigation of nursery stock or other materials with hydrocyanic acid or other gases. We have several houses constructed for that purpose, and all Maryland nurserymen are now required by law to fumigate every tree they grow or handle.

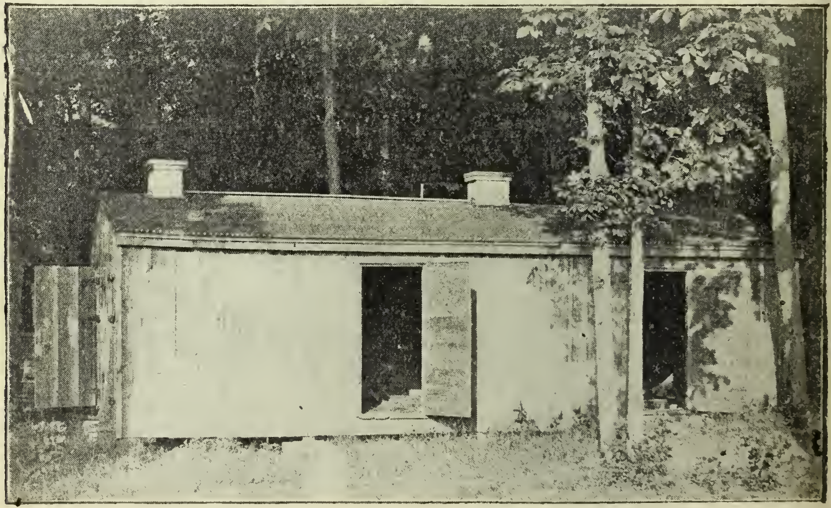

Figure 26.—Fumigatorium, or house for treating nursery stock with hydrocyanic acid gas. Photo by W. G. Johnson.

One of the largest houses in this country, used for fumigating purposes, is shown at figure 26. It is 32x16x8 feet with a roof pitch of two feet, and is divided into two large rooms about 15x14x7 feet and two smaller rooms 4x5x7 feet, constructed as follows:

First, a good, substantial frame is built which is covered outside with 1¼ inch 12-inch Virginia pine boards, and ½x4 inch batting. The interior is first lined with two-ply cyclone paper and then with 4 inch flooring. The partitions and floors are also double with paper between. The roof is covered with heavy roofing paper, tarred and graveled. The doors are 6½x3 feet (3½ feet would be better), made double, refrigerating style, and hung with three heavy strap-iron hinges, and held in place when closed with two bolts. At the top of each large room on the opposite side there is a door 3x2½ feet for ventilating purposes. There is also a flue opening between the rooms as shown in the illustration, which can be uncapped when it is desired to air the house

In building a house of this kind it must be born in mind constantly that it is to be gas-proof, and to accomplish this, no slovenly workmanship is permissable.

A fumigatorium the size of the one just described is sufficiently large for a person or firm handling annually a million or more trees. Where 100,000 or more trees are handled each season, a smaller house containing a single room can be used. A convenient size is from 12 to 15 feet square, and 7 feet high, inside measurements. One even smaller would suffice, depending of course upon the amount of nursery stock grown or handled. In fact, almost any reasonably tight room can be repaired and used; but one must make sure it is gas-tight.

After all, a fumigatorium is not so expensive. When not being used for fumigating purposes, which lasts only a few months in the fall and spring, it can be used for any other purpose, and such buildings are necessary in any well established nursery.

How the Work is Done:—The trees are dug from the nursery and loosely packed in the fumigatorium either on end or flat on the floor. The chemicals are then prepared and properly placed as near the center of the room as possible, after which the doors are closed and left for a half to three-quarters of an hour. A half hour is the minimum limit, but dormant trees are not hurt in the least if left even over night, and it is necessary to do this at times as the house is filled at the quitting hour. After fumigation, the trees are packed for shipment or heeled in on the yards.

I have determined by a long series of experiments this spring (1898), that nursery stock even after the buds have begun to unfold will stand a much greater amount of gas and for a longer time than was formerly supposed. There is not the slightest danger of injuring nursery stock by a single, double, or even treble fumigation.

I have found by experiment that I get the best results when I use

25 grams (a little less than 1 oz.,) (by weight) Potassium Cyanide, 98-99 per cent. pure.

1¼ ozs. (liquid measure) Sulphuric Acid, best grade commercial, (sp. gr. 1.83).

1⅞ ozs. (liquid measure) Water

for every 100 cubic feet of space enclosed. These amounts can be used for every 75 cubic feet if desirable; but, ordinarily, it is not necessary.

The chemicals are weighed, prepared, and used as described on page 77.

Fumigating Buds:—It is very desirable to fumigate all buds, from whatever source they come, before allowing them to be budded into the nursery. By taking this precaution a great deal of trouble may be averted. As an illustration of the importance of this I merely cite one instance. Last summer while inspecting one of our large nurseries, I noticed a box containing some apple buds from a central-western nursery which had been lately received, and, upon examination I found these infested with the San Jose scale. The few scattered scales would have escaped the eye of the nurseryman and would with great certainty have been budded into the nursery, had they not been intercepted. By fumigating, even though they had been overlooked, the scales would have been destroyed.

The process for fumigating buds is the same as for trees, but a special box should be made for the purpose. A convenient sized box for large nurserymen is one 4x2½x2½ feet. It requires .22 ozs. Potassium Cyanide, .33 ozs. Sulphuric Acid, and a trifle over .50 ozs. of water.

A box 2x2x2½ feet is a convenient one for smaller nurserymen; but such small boxes are not desirable on account of the diminutive amounts of chemicals used; for a box this size 2.5 grams cyanide, 3.75 cc. of acid, and 5.62 cc. of water.

A nurseryman can make almost any box perfectly tight by painting and papering. In fact, a label box can easily be converted into a gas-box. Of course the chemicals necessary can be easily calculated when the capacity of the box is known, using .25 grams of cyanide, .37 cc. acid, and .56 cc. of water for every cubic foot of space.

Caution:—It must be remembered that Potassium Cyanide is *one of the most deadly poisons* known, and that nothing is more destructive to animal life when inhaled than hydrocyanic acid gas.

When removing a tent or box care should be taken so as not to inhale the gas. The doors in a fumigatorium in which gas has been generated should be thrown open and allowed to air, at least *10 minutes* before any person is allowed to enter. This is a rule that must be strictly observed, otherwise life is endangered.

A fortunate accident happened in one of our fumigating houses last fall which should be a signal warning to those who may use this gas. The house had been filled with Norway Maple trees and after the usual length of time the doors were thrown open. At the expiration of seven minutes, a negro laborer who had been repeatedly warned not to enter the room under ten minutes, went in and began handing out the trees to another negro who was standing at the door. He handed out two bundles and while stooping for the third, fell headlong on the floor. He was immediately pulled out, laid on his back in the open air, recovered consciousness in about fifteen minutes, and was seemingly as well as ever in half an hour. When asked what had happened and how he felt, he replied, "De Lord only knows dat stuff am a powful axfitter."

It is needless to say that this negro, and no others on the place, have since entered the room under 10 minutes after the doors were opened.

Another peculiar accident happened during our experimental operations at Capt. Emory's. Our cyanide having been shipped to us in lumps too large for use, we found it necessary to break it up in smaller pieces. In order to do this and keep it from flying, we covered it with an old fertilizer bag. After the cyanide had been removed from the bag, and the smaller particles shaken out, the bag was again shaken out the window to free it of any particles that may have remained. As a result, a few very small pieces, not larger than a pin's head, were shaken on the ground. Two fine, large chickens, especially prized by their keeper, roaming about, picked up some of the cyanide, and in less time than it takes to write this account, they were on their backs. One died in a very few moments, while the other recovered, evidently not having gotten so much.

Prof. Woods tells me that a favorite cat, which was asleep under a bench in one of the greenhouses he fumigated, was killed without being awakened. A dog was placed in one of our fumigating houses to test the effect of the gas upon animal life, after the room had been opened and aired for seven minutes, and again closed. The animal was removed after five minutes exposure in an unconscious condition, but recovered in half an hour. Many instances could be cited, but this will suffice our purpose in warning those who use cyanide or hydrocyanic acid gas that they are exceedingly dangerous substances.

EXPERIMENTS WITH OTHER SUBSTANCES.

WHALE OIL SOAP.

Whale oil soap has for a number of years been the standard remedy used against the San Jose scale, and is perhaps to-day the safest and best all-around material for the destruction of this insect upon bearing trees. Professor J. H. Comstock was the first to use this material against scale insects in general, calling attention to it in his annual report as U. S. Entomologist in 1880. The discovery of its efficiency for the destruction of the San Jose scale, however, belongs to Robert S. Emory, of Chestertown, Maryland. In 1892, when Mr. Emory first discovered that there was something wrong with a block of Lawson pear trees, he became alarmed, and thinking the trouble was due to a species of scale insect, he immediately set to work for its destruction. Having a supply of whale oil soap on hand, which he had been using against the pear leaf slug, he applied this material as a winter wash to every infested and suspected tree. He diluted the soap with water to a consistency of thick, soft soap and coated the trunks and larger branches of the infested trees with it. Mr. Emory followed up this treatment the fall of 1893, and by so doing, kept the insect somewhat in check.

In 1894, Mr. Emory called upon Dr. Howard to assist him in checking the further spread of the pear Psylla, which was very abundant in his orchard. It was at the time of Mr. Marlatt's visit, who was detailed to make the investigation, that Capt. Emory called his attention to his treatment of the pear trees infested with scale. At first Mr. Marlatt expressed considerable surprise, stating that he would have been of the opinion that whale oil soap applied in so strong a solution would have destroyed the trees. It appears that Howard and Marlatt began their extensive series of experiments with whale oil soap in Mr. Emory's orchard and in a large peach orchard at Riverside, Charles county, shortly after this conversation. The details of their experimental work are given in Bul. No. 3, n. s. Division of Entomology, U. S. Department of Agriculture. The results of these experiments were very satisfactory, and showed beyond all possible doubt, that whale oil soap, properly diluted, was the best and most satisfactory remedy for the destruction of the scale.

Mr. Emory conducted his experiments with the soap in the fall of 1895, varying his operations somewhat, from the fact that he used a spray pump, instead of applying the material with a brush as formerly. During that season he used over seven barrels of soap, an equivalent of about 2,800 pounds. In the fall of 1896 he again sprayed every tree of the infested block with soap at the rate of from 2¼ to 2¾ pounds in a gallon of water, using in all that season 14 barrels, or about 5,600 pounds. During the fall of 1897 five more barrels, or about 2,000 pounds, were used in spraying the blocks which were not fumigated or treated with other substances.

In view of these facts we can say, without fear of contradiction, that Mr. Emory has had more experience spraying with whale oil soap for the destruction of the San Jose scale than any other orchardist East of the Rocky Mountains or, perhaps, in the United States. I have had an unexcelled opportunity for watching the results of this heroic treatment, and have been given every facility on the part of Mr. Emory for making observations.

Kind of Soaps:—The whale oil soap first used was made with caustic soda, and when diluted with water and sprayed upon trees, left a whitish coating or residue. This soap was also used with some difficulty, from the fact that it became a semi-solid when partially cold, and was sprayed with considerable trouble unless applied while hot.

This difficulty was overcome by having a soap made with potash lye, which could be used either hot or cold. At the meeting of the Association of Economic Entomologists at Buffalo in 1896, Mr. Marlatt stated that most of the brands of whale oil soap on the market were unreliable, and indicated that the soda was much inferior to the potash as an emulsifying agent for insecticide soaps. By request, he had Mr. James Good, of Philadelphia, make a potash soap which fulfilled the requirements, and which was recommended for use by entomologists.

From our experience, however, in Maryland during the fall and winter of 1896, we found it very difficult to get a uniform grade of potash soap. Of the 14 barrels used by Mr. Emory, purchased at three different times, no two lots were of the same uniform consistency and had the same effect when applied to the trees. The first lot was all that could be desired, and answered every purpose very satisfactorily, while the second lot was of a very inferior quality, though sold for the same grade, and when diluted with water, looked more like raspberry juice than the very dark uniform color of the first lot. The third lot was a little better than the second, though not as good as the first. After considerable correspondence with Mr. Good, Mr. Emory ascertained that it was almost impossible to get materials exactly alike for the manufacture of these soaps in large quantities. After this experience, however, we have now upon the market several brands of whale oil soap which meet all our requirements for insecticide work. We have been using "Good's Potash Whale Oil Soap No. 3" in all our experimental operations, and have found it a very satisfactory material. During the last year, the grade has been quite uniform, and we have little or no difficulty with it. We have also tested the "Anchor brand," sold by Leggett & Bro., of New

York City, and found it also very satisfactory. Good's No. 3 soap can be purchased in 275 pound kegs, or 475 pound barrels at from 3 to 3½ cents per pound in Philadelphia. In smaller quantities of from 50 to 170 pounds it costs from 4 to 5 cents per pound.

Application:—Whale oil soap must be diluted with water at the rate of two pounds in a gallon, and applied while hot or lukewarm during the fall, winter or early spring months to get the best results. It must be understood, however, that the soap in this solution cannot be applied to trees in full foliage, as it will destroy the foliage and buds, and seriously injure, if not kill, the trees. It is recommended for a winter treatment, and should be used at the times indicated, when the trees are not in foliage.

In preparing this soap, where one is using large quantities it is necessary to have a large iron or copper kettle, in which the water can be heated, and into which the soap is placed and thoroughly dissolved before being used. It is desirable to have the kettles where the water and the materials are convenient, and at the same time, at some central point in or near the orchard to be treated. Soap diluted in this way can be applied safely to nearly all of our deciduous fruit trees, except peach, usually without injury to the fruit or leaf buds. The fruit buds of peach, on the other hand, are sometimes destroyed by spraying with soap in a two pound solution. It should, therefore, be used cautiously and with care on peach trees, if it is desirable to secure any fruit the following season.

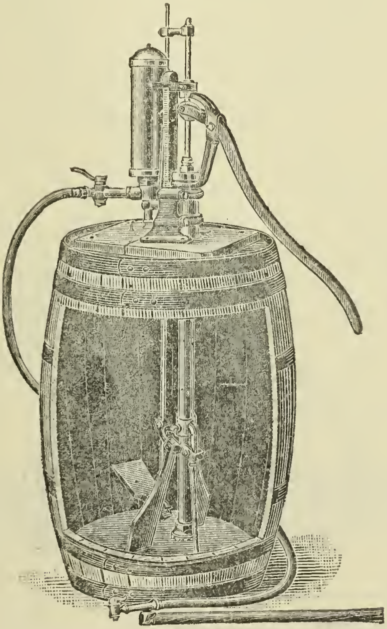

Figure 24.—The Peerless Barrel Sprayer
(After the Deming Co.)

I desire also to state in this place that during Mr. Emory's spraying operations in 1896, where he used the soap at the rate of from 2¼ to 2¾ pounds per gallon, as a consequence, many of the trees were severely injured. Considerable dead wood was cut out the spring of 1897. On the other hand, where the soap was used at the rate of 2 pounds to a gallon, none of the trees were injured.

Apparatus:—In view of the fact that the soap has a softening effect upon leather, spraying pumps with leather valves are not desirable. The most satisfactory and convenient spraying devices, therefore, are those made with metal valves, such as the "Peerless" (Figure 24), manufactured by the Deming Company, Salem, Ohio, or the "Aquapult," made by W. & B. Douglas, Middletown, Connecticut. This latter pump is a very convenient and inexpensive one. An outfit whic has been designed and used successfully in a number of our large orchards for some years past, is shown at Figure 25, and I have named i the "Emory Spraying Outfit," from the fact that it was designed and firs used by Mr. Emory.

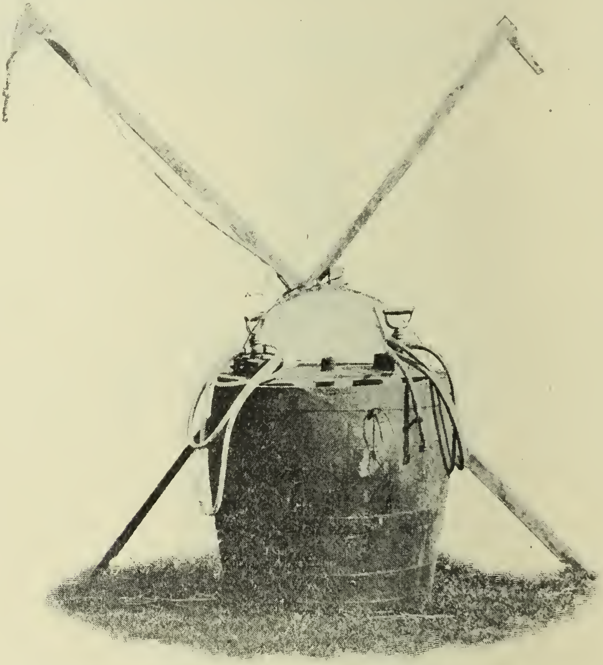

Figure 25.—Emory Spraying Outfit. Photo. by W. G Johnson.

The apparatus consists of one or two Aquapult pumps placed in barrel, cut to the proper height and covered, as shown in the illustration These pumps are fitted with a 10 or 12 foot section of one-half or thre quarter inch hose, a stop cock and one Cyclone or Bordeaux nozzle. Th entire cost of one of these pumps, with hose, nozzle, etc., is about fiv dollars. Of course, where two pumps are used in the same barrel, the cost would be double, but for ordinary purposes, one is all that is necessary. The barrel is placed in a wagon or cart, and one man can operate it successfully by pumping with one hand and spraying with the other, directing the spray upon the trees with the pole connection, as shown in the figure.

Until we find a better remedy to be applied as a spray for the destruction of the San Jose and other scale insects, we shall continue to recommend the use of whale oil soap at the rate of 2 pounds to a gallon of water, applied during the dormant condition of the trees.

NEW SOAPS.

After some correspondence with W. S. Powell, President of the Powell Fertilizer and Chemical Company, Baltimore, Md., I succeeded in getting two soaps, designated Nos. 1 and 2, made as follows:

No. 1.—A mixture of mineral oil, fish oil and sulphate of potash, containing of the latter about 35 per cent. It was believed that the mineral oil used would have better solvent properties than the fish oil heretofore used in making whale oil soap.

No. 2.—Was made of foots, that is, the residue after pressing the oil out of fish chum with sulphate of potash, making a soap containing aproximately 50 per cent. of sulphate of potash.

A young apple orchard, located near Brookville, Montgomery county, belonging to James B. Hallowell, and slightly infested with the San Jose scale, was selected for the purpose of making the experimental tests with these soaps. Six apple trees, about six years old, quite badly infested with the scale, were selected, and the soaps were used at the rate of 1, 1½ and 2 pounds per gallon, and applied May 18th, 1897, when the trees were in full foliage. The experiments were as follows:

No. 1—Soap No. 1.—May 18, Albemarle pippin apple, moderately infested with the San Jose scale, treated with 12 quarts of spray diluted at the rate of 1 pound to a gallon.

No. 2.—Same as No. 1, except that the soap was diluted at the rate of 1½ pounds in a gallon of water.

No. 3.—Duplicate of Nos. 1 and 2, except that the soap was used at the rate of 2 pounds in a gallon of water.

Twigs cut from the preceding experiments were examined June 10, 1897, and we found that the foliage had been injured slightly on the one pound dilutions, and very severely where the two pounds were used. At the same time, one living female scale was found. July 15th another examination was made, and we determined that about 5 per cent. of the insects were living, while the foliage had been damaged considerably. At this time also, a considerable number of young larvae were found crawling over the trees.

No. 4.—May 28th. Fall pippin. Soap No. 2. 1 pound to a gallon of water, 12 quarts of spray used on tree.

No. 5.—Albemarle pippin moderately infested, sprayed with 6 quarts diluted at the rate of 1½ pounds in a gallon. No. 6.—Fall pippin sprayed with 6 quarts diluted at the rate of 2 pounds to a gallon. Tree very badly infested, the branches and twigs being literally covered.

Twigs cut from experiments Nos. 4, 5 and 6 were examined May 28th, and we found that fully 90 per cent. of the insects were living, and that the foliage had not been injured.

Other examinations were made June 10th and July 15th with the same results, at which latter date the young larvae were very abundant and crawling. From these experiments, it appears that soaps made according to the above formulas cannot be used to advantage for the destruction of the San Jose scale. While soap No. 1 was fairly satisfactory, the injury to the foliage was such that we could not recommend it for general use during the spring or summer. On the other hand, soap No. 2, while not effective in destroying the scale, also has other objectionable features, in that it must be applied when quite hot, otherwise it solidifies readily, stopping up the hose and nozzle. Up to the present time, we have found no soap as effective as a good quality of potash lye whale oil soap.

PURE KEROSENE ON YOUNG AND BEARING TREES.

Our experience with pure kerosene is such that we cannot recommend it for spraying either young trees or bearing trees in the orchard, unless done under our own personal supervision. The work of Messrs. Marlatt and Coquillett, of the Division of Entomology, United States Department of Agriculture, on bearing peach trees in Charles county, this State, during the winter of 1894-95 was of such a nature that it was not thought expedient at that time to continue the experiments with pure kerosene or undiluted kerosene emulsion, as all the peach treated with these substances were killed (Bul. No. 3).

Later experiments, notably by Messrs. Webster, Marlatt, Smith, Alwood and myself show conclusively that the physiological effect upon the plant varies with the kind of tree, and upon the time and manner in which the application is made.

After Mr. Marlatt summarized the results of his later experiments with pure kerosene in a paper before the Association of Economic Entomologists at Detroit, in August, 1897, he says: "These results are so greatly in contrast with those previously attained in the experiments conducted in practically the same way, that it seems difficult to account for them. That spraying with pure oil will often kill trees cannot be doubted, even when applied in the dormant condition in winter, as demonstrated by experiments on a number of apple and peach trees two or three seasons ago. It is possible that with these earlier experiments, the same care was not employed to prevent the collection of oil about the trunks of the trees, and the trees were not mounded up, but the work was as carefully done as would ordinarily be the case in actual practice, and probably much more so. It is possible, therefore, that the death of these trees in some instances, was due to the collection of the oil in the cavity formed about the trunk by the swaying of the trees in the wind, which as will be shown later, has had disastrous results in California with the emulsion even. Others have reported the use of oil on trees without injurious effects in some instances, and in others with injurious effects, so that pure oil as an insecticide is one to be used with full appreciation of the fact that the death of the plant may result."

A partial summary of the results of Prof. Alwood's experiments, conducted in March, 1897, was published in Bulletin No. 72, Virginia Station, in January, 1898. He related that he believed that pure kerosene could be safely used on all the hardy fruit trees, but, fearing serious results, he was not willing to recommend it in the hands of untrained persons.

In a later publication (Bul. No. 74, Va. Sta.) received May 1st, 1898, Prof. Alwood records a number of experiments made by him in March, 1898. Giving the results of this work up to April 22nd, he says: "The foregoing abstracts and unpublished matter in the records of the work now in progress show that pure kerosene can be safely used upon all our fruit trees in the dormant season, and with proper precautions during the growing season also. The chief point to be observed in its application is the proper atomization of the kerosene. Unless it be applied in a finely atomized condition, and in quantity so as to just moisten the parts of the plant, there is danger. The skill and judgment necessary to insure safety in this work are not such as to preclude the use of kerosene by fruit-growers, hence, in the light of the above, and other unpublished experiments, I recommend it as a summer treatment for the San Jose scale. I believe it to be the treatment *par excellence*, as in every case where I have used it on this scale, it has destroyed them with great certainty. It is too soon to make an absolute statement as to the degree of efficiency, but the experiments now under way will furnish much data on this point by the end of the season."

The outcome of the carefully prepared series of experiments by Professor Webster, recorded in Bul. 81, Ohio Station, was very different from the results obtained by Professor Alwood. Professor Webster's experiments were conducted in March, 1897, upon pear, apple, peach, plum, and cherry. The kerosene was applied in a fine spray and with a brush. Out of 23 trees treated, 14 were either killed or seriously injured. Of 6 peach trees, 4 were killed and 2 greatly injured. Reviewing his experiments, Professor Webster says: "Judging from all the information we have gained, it seems that kerosene cannot be safely used on peach trees, or on plum trees of tender varieties, but that, if applied lightly, with a brush to the more hardy plums, pears and apples, especially the latter, it can be used safely, especially if trees are cut back to trunks and bases of limbs."

The results obtained by the experiments of Prof. Smith in 1897, were of such a nature, that he issued a circular September 1st, 1897, advising the use of pure kerosene. He was of the opinion that summer applications would be more effective than winter treatment, and placed much emphasis upon a thorough spraying of bearing trees with kerosene in September, printing the following sentence in large type: "Spray thoroughly in September all infested bearing apple, pear, plum and peach trees with undiluted kerosene during the middle of a clear sunshiny day." It was further stated that if the tree was covered with the finest possible spray, wetting every part of the plant, one application would be sufficient.

In January, 1898, Professor Smith issued Bul. 125, N. J. Station, in which he further recommends the use of pure kerosene, stating that, "it (kerosene) has, however, been also proved, that with proper care and attention, the oil can be safely used on fruit trees, dormant or active, and that it will kill all the scales with which it comes in contact. In fact, my results are such, that I am not sure that it is not safer to use the oil on tender trees like peach when active, than when dormant."

Further on, Professor Smith says: "The essential points to be regarded in the application of kerosene are the finest possible spray, the completest and thinest possible coating over the entire surface, and weather conditions favoring rapid evaporation. The trees themselves should be dry. Any departure from these suggestions may cause injury, for I wish it distinctly understood that kerosene improperly used, is fatal to plant life."

In Bulletin No. 12, Dr. L. O. Howard, U. S. Entomologist, reviews the experiments made with pure kerosene in various places, and cites an instance where one of his North Carolina correspondents had been prompted to use pure kerosene upon a newspaper recommendation, in September, 1897, and had lost 90 per cent. of the trees sprayed in his 400 acre peach orchard. Dr. Howard says: "It is from such experience as this that we have decided not to recommend the pure kerosene spray as the result of any one's experience, without first advising the individual fruit grower to experiment in a small way and determine for himself by experience in his own locality and under the local conditions which exist there, whether he can use kerosene to advantage." Dr. Howard says, that if he were a fruit grower, he would experiment for himself with pure kerosene and base his conclusions on his own individual results.

The Farmers' Review, May 28th, 1898, contains a note from their stenographic report of the Illinois Horticultural Society Proceedings, bearing on this topic. In reply to an inquiry regarding the San Jose scale, Mr. Morrill, one of Michigan's largest fruit growers and also a manufacturer of spraying apparatus said: "A year ago at this convention we heard men tell of spraying coal oil on trees and not hurting them, and it looked as if it was not harmful. Sometime after that we got an order for special nozzles made very small so that they could be used for spraying with coal oil. We made them so small that they would only throw a mist. We wrote the people who had ordered them that we believed they would kill every tree sprayed with kerosene. They replied that it did not make much difference, as the trees were no good as they were, and they would try the kerosene anyway. I saw a man from that locality recently and he said they had killed 30,000 peach trees by the spray."

RESULTS IN MARYLAND.

After reviewing all the experiments in Maryland, I state most emphatically that pure kerosene sprayed even in the hands of an expert and in the most careful manner possible, with favorable weather conditions, is a dangerous substance to the vitality and life of young and bearing trees. In all the experiments conducted in this state with pure kerosene on bearing trees, the tree has either been killed or injured, or the fruit buds have been killed.

The most disastrous results are recorded in experiment No. 5, where a block of beautiful nine year old Buffum pear trees were destroyed. Capt. Emory, who is a very careful student of current literature bearing upon fruit culture, was prompted to spray the entire block of 400 trees with pure kerosene upon the recommendation made in Bul. 125, N. J. Station, which he received in January, 1898. When asked my opinion regarding this treatment, I strongly urged Capt. Emory not to spray the entire block, but to limit his spraying to half a dozen trees and see the results. Instead of using a few trees, 132 were sprayed as noted under the experiments. The results were so conspicuous, I desire to call the attention of my constituents to figure 21, which shows one of the sprayed trees reproduced from a photograph taken by myself May 24th, 1898. As companions to this, I have reproduced also one of the trees in the same block which had been sprayed with whale oil soap, Figure 22, and one that had the top killed and which had been trimmed back, Figure 23. This ocular demonstration ought to be sufficient for the most skeptical. Capt. Emory assures me that had it not been for my appeals to him not to spray with kerosene, he would have killed his entire orchard, and thus lost several thousand dollars, as the trees are now laden with fruit. It is needless for me to say that this experience is sufficient for one of Maryland's largest and most successful fruit growers, and that he is now thoroughly convinced that pure kerosene "sprayed during the middle of a sunshiny day," in the "finest possibel mist," in the hands of an expert, is surer death to certain trees than the San Jose scale.

On the other hand, a block of thirty year old Duchess sprayed with kerosene at the same time, and under the same conditions, were not killed, as noted under experiment No. 6, but at the same time all of the fruit buds were killed, and the development of the foliage retarded. So serious is the damage to the fruit in this block, Capt. Emory asserts, that he could take the difference between a total failure and half a crop, as is the case with trees fumigated and sprayed with whale oil soap, and buy enough cyanide or whale oil soap to treat his entire orchard.

In every instance on bearing trees, whether sprayed the "middle of a September sunshiny day," in mid-winter or spring, from 80 to 100 per cent. of the fruit buds have been killed, and the vitality of the tree more or less affected, if not killed. With young trees, especially peach and plum, and in all cases with pear and apple, the growth has been retarded.

Our experience with pure kerosene emulsion, and kerosene emulsion diluted in various ways, and kerosene mechanically mixed with water, are such that we cannot at present, make any general recommendations, other than this suggestion, that it will be good policy to use kerosene in any form cautiously.

Summing up these results, it seems certain, (1)—That pure kerosene cannot be safely recommended in this state as a spray for young and bearing fruit trees at any time of the year; (2)—That very old trees of certain varieties, such as Duchess pear, resist the destructive effects of pure kerosene more than younger bearing trees, such as Buffum pear, a condition no doubt, due to the fact that the wood of the very old varieties is firmer and more mature, thus resisting the penetrating properties of the kerosene; (3)—That from 80 to 100 per cent of the fruit buds are killed on bearing trees, whether sprayed in the fall, mid-winter or spring; (4)—That young trees, especially peach and plum, are seriously injured or killed; (5)—That pure kerosene emulsion or kerosene diluted in any

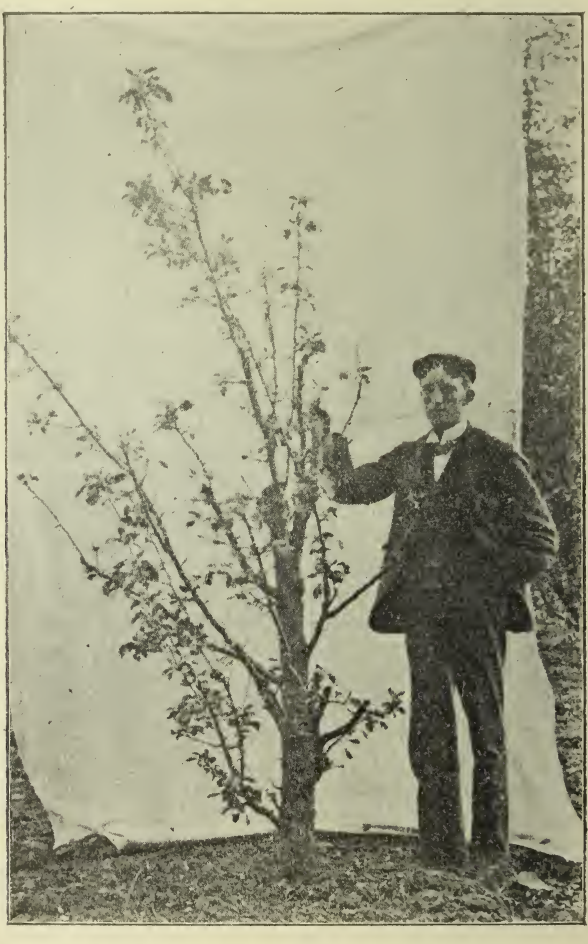

Figure 23.—Buffum pear tree, cut back after spraying with pure kerosene. Photo. taken May 24, 1898, by W. G. Johnson.

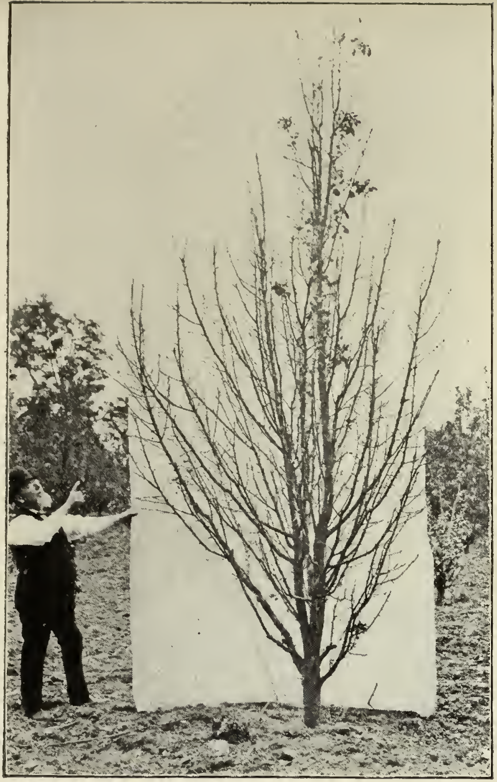

Figure 21.—Buffum pear tree killed by spraying with pure kerosene. Photo. taken May 24, 1898, by W. G. Johnson,

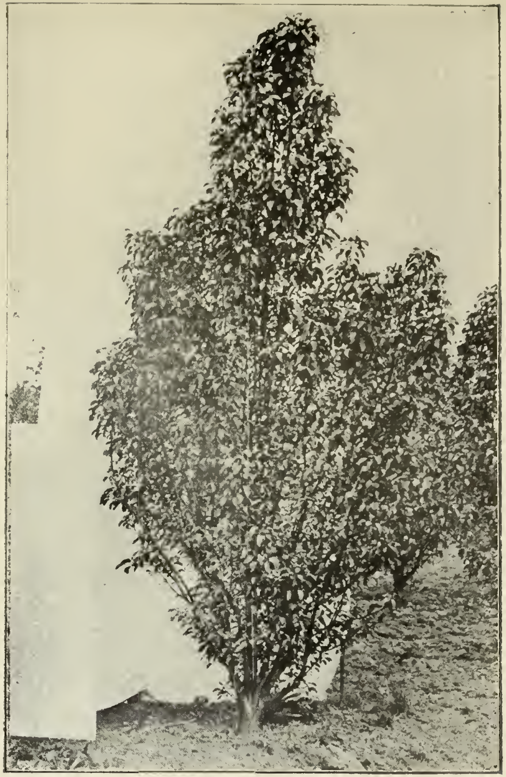

Figure 22—Buffum pear sprayed with whale oil soap. Photo. taken May 24, 1898, by W. G. Johnson.

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form, cannot be safely recommended until further experiments are conducted.

From what I have seen of the effects of pure kerosene upon fruit trees, my final advice to the peach and pear growers, especially, of Maryland, is this, *beware of mineral oils.* If you desire to use pure kerosene, first try it upon a few trees, and decide for yourself whether or not you think it safe to continue the practice.

Pure Kerosene:—The four following experiments were performed in the pear orchards of R. S. Emory, at Chestertown, Kent county.

No. 1. November 6th, 1896, a six year old standard, Bartlett pear tree, badly infested with San Jose scale; sprayed during the middle of the afternoon; sun shining; strong breeze. Tree 16 feet in height; 6 quarts kerosene, 175 degree test used. Tree sprayed from three sides. November 19th, a little less than 20 per cent. of the scales living. The wind carried a fine mist of kerosene, so that it covered one side of a dwarf Bartlett in an adjoining row. The entire side of this tree was killed and cut away. November 24th, tree sprayed with whale oil soap, 2 pounds to a gallon of water. April 16th, buds beginning to unfold. Some little dead wood on young twigs. May 23rd, full foliage, no fruit, dead wood all cut out. August 27th, a few old females, and many larvae seen crawling about the tree. October 14th, about the same number of living scales as on any neighboring tree.

No. 2. A six-year old dwarf Bartlett pear tree in good condition about 10 feet high, and moderately infested with San Jose scale, selected and sprayed with three quarts kerosene at 11 o'clock September 30th, 1897. Temperature, thermometer hanging in tree, 74 degrees F.; sun shining brightly; gentle breeze stirring. Sprayed by myself from three sides. October 14th, leaves a little more yellowish than on surrounding trees. Foliage apparently not seriously damaged. October 28th foliage all off. Leaves dropped several days before those on surrounding trees. March 29th, 1898, Capt. Emory writes that 99 per cent. of the fruit buds have been killed, while the leaf buds seem to be alive; but very much retarded. May 5th, I examined the orchard and found the tree in full foliage, but fully 99½ per cent. of the fruit buds killed. Only an occasional fruit bud on extreme tips in top of tree. Trees surrounding set full of fruit. Could not find any living scale.

No. 3. Tree similar to No. 2, about same size, and moderately infested. Sprayed with three quarts kerosene at 5.30 o'clock p. m., September 30th, 1897. Temperature 70 degrees. Gentle breeze. October 14th, foliage practically all on and green; drops readily when tree is shaken; but not so easily as in No. 4. No living scale observed. October 28th, foliage all off; one living scale found. March 29th, 1898, Capt. Emory reports 99 per cent. of fruit buds killed, and leaf buds greatly retarded. May 5th, I find the tree in full foliage, but considerably less than on surrounding trees. Fruit buds practically all killed. Only an occasional one on extreme tips of topmost branches. Found no live scale.

No. 4. Tree similar to Nos. 2 and 3. Sprayed with three quarts of kerosene October 1st at 6.30 a. m. Temperature 64 F., gentle breeze. October 14th, foliage practically all on, but falls very easily when shaken.

Found no living scale. March 29th, 1898, Capt. Emory reports that fully 75 per cent. of the fruit buds are killed. May 5th, I found the tree in full foliage, but not so dense as on surrounding trees. Fruit fairly well set on the east side and on terminals. Found no living scale.

This tree was also treated with hydrocyanic acid gas October 16th, 1897, for half an hour, with 1¾ ozs. cyanide, 2 ozs. acid, and 5 ozs. water. With this double treatment, fully 75 per cent. of the fruit buds were killed. I will not attempt to explain the cause of this condition, as there are too many factors to be considered, and a general conclusion or deduction would be misleading.

The two experiments next reported were performed by R. S. Emory in his orchard the middle of January, 1898.

No. 5. A block of 400 Buffum pear trees about eight years old and in their prime, were slightly infested with the scale. Desiring to check its further spread in this orchard, Capt. Emory decided to spray the block with pure kerosene, having seen the recommendation of Dr. Smith in Bulletin No. 125. Not being at all certain about the effect of this treatment upon bearing trees, especially when applied in mid-winter, I advised Capt. Emory not to spray the whole block, but limit his experiment to a few trees, and first see the physiological effect. A barrel of 150 degree test kerosene was procured and applied the middle of January during a bright, sunshiny day. 132 trees were sprayed by an expert. An aquapult spray pump, fitted with a cyclone nozzle having a very fine bore was used.

It was apparent a few weeks later the kerosene had seriously injured the trees. The wood of the last two years growth was black. I visited the orchard May 5th, and found nearly all the trees dead. Several of them had a few leaf buds starting here and there among the larger branches, but a more sickly, desolate lot of trees I never saw in my life. It was all the more striking on account of the fact that the trees which had not been sprayed, were in full foliage, and stood out in bold contrast for comparison. Possibly some of the sprayed trees can be saved by cutting them back to the stumps, as there are a few that seem to have some life.

No. 6. In this experiment, the trees selected were in a block of twenty-five year old dwarf Duchess pears. The spraying was done in a similar manner to that described under No. 5, and under the same conditions. The same amount of kerosene was used, that is, three pints to a tree. No dead wood was observed after the treatment, and from the general appearance of the trees May 5th, they had not been seriously damaged by the treatment, so far as wood was concerned; on the other hand, however, all the fruit buds had been killed, while the trees on one side sprayed with whale oil soap, and on the other side not sprayed at all, were set full of fruit.

The two following experiments were conducted near St. Margaret's, Anne Arundel county, in the orchard of A. A. Stinchcomb. An apple and plum tree about five years old, and badly infested with the San Jose scale were selected for the purpose.

No. 7. An apple tree sprayed with two quarts of pure kerosene March 3rd, 1898. Weather cold and sun shining. Strong wind from northwest. The foliage was greatly retarded upon this tree; but it has made a feeble growth. No living scale has been found upon it.

No. 8. A plum tree sprayed on same date as No. 7 with two quarts of kerosene under similar conditions. This tree started a feeble growth of foliage which shriveled up and died about June 1st.

The three experiments which follow were conducted at College Park upon young trees set out one year ago this spring, and all were in excellent condition.

No. 9. Two peach trees with blossoms just ready to open, each sprayed at noon March 17th, 1898, with one pint of kerosene 170 degree test. The sun was shining brightly and a gentle breeze blowing. March 28th, a terminal blossom open. None open on check trees. Petals a little brownish. Buds seriously hurt. March 30th, only fourteen blossoms open on sprayed trees, while checks are in full bloom. Petals and buds all hurt. Smaller twigs turning black, wood evidently hurt. April 15th, fruit buds all killed. A few leaf buds beginning to show themselves on the main stem. Small twigs black and dead. Trees seriously hurt. Two other peach trees same age and sprayed at same time, with whale oil soap, two pounds to a gallon of water not damaged. Both in full foliage; there is no fruit, but there is none on the checks, a condition due, probably, to the severe cold snap and snow storm April 4th and 5th. May 1st, trees still alive, but with only a few clusters of leaves upon the trunk. May 15th, growth shooting rapidly from trunk. Smaller twigs and branches dead. Checks making a beautiful growth.

No. 10. One Abundance plum tree sprayed with a pint of kerosene same day and same conditions as No. 9. The leaf buds were well unfolded. March 28th, buds shooting rapidly. March 30th, few clusters of blossoms out to-day. Leaves rather thin. April 15th, leaves slowly developing. Tree, same kind, sprayed with two pounds of whale oil soap making a good growth. May 1st, foliage on sprayed tree growing, but slowly, and leaves are scattering. May 15th, tree greatly dwarfed, although the foliage is recovering. Tree sprayed with soap fully one-third larger at this time.

No. 11. A Garber pear tree sprayed same as Nos. 9 and 10, with one pint of kerosene under similar conditions. Five others sprayed same day with whale oil soap two pounds in a gallon of water, and two trees left as checks. March 30th, buds about ready to open. April 15th, leaf buds opening on all the trees; but less conspicuous on the tree treated with kerosene. April 30th, leaves well out and tree making good growth, except the one sprayed with kerosene. On this, the buds are retarted and slowly unfolding. The foliage is not as dense as in the other trees. May 15th, tree in fairly good condition, but with only about two-thirds as much foliage as on other trees. No dead wood. There were no fruit blossoms on any of the trees.

The tree selected for the following experiment was a bearing tree planted the fall of 1893, in the orchard of W. S. Powell, Annapolis Junction.

No. 12. An Abundance plum tree very badly encrusted with the scale, with the leaf buds unfolding, was selected for this purpose, and sprayed during the middle of the afternoon of March 17th, 1898. Bright sunshine, and gentle breeze. April 10th, leaves very badly hurt, few young twigs killed. Tree trimmed next day after being sprayed. No live scale found May 10th, foliage considerably hurt; very thin as compared with trees treated with gas and whale oil soap. No fruit set. A microscopic examination of the scales on twigs cut from the tree show that all are dead, so far as can be determined at present.

Kerosene Diluted:—In the following experiments, I used kerosene emulsion (½ pound soap, 1 gallon water, 2 gallons kerosene), pure and diluted. All the trees were moderately infested with scale.

No. 13. November 6th, 1896, a five year old dwarf Bartlett pear tree about ten feet high selected and sprayed with six quarts of kerosene emulsion undiluted. It was put on hot, and the tree was sprayed from three sides. An examination November 19th showed that a considerable number of the scales were still living and the tree was resprayed November 24th, with whale oil soap (two pounds solution). The tree was uninjured on account of the treatment, and was set as full of fruit as any in the adjoining rows.

No. 14. A tree adjoining and similar to that used in No. 13 was sprayed same date with equal parts of kerosene emulsion and two pound solution of whale oil soap. Six quarts of the mixture used. Results similar to those obtained in No. 13.

No. 15. Kerosene emulsion diluted with equal parts of water, and then combined with equal parts of whale oil soap, two pound solution, and sprayed upon a tree similar to those used in Nos. 13 and 14, using six quarts of the combined mixture. Results not unilike those obtained in Nos. 13 and 14.

The three following experiments were made in the orchard of A. A. Stinchcomb, St. Margarets, Anne Arundel county. All the trees were from five to six years old and badly infested with the scale. The spraying was done with a success kerosene sprayer, and cyclone nozzle with very fine opening. The day was cold and blustery.

No. 16. An apple tree ten feet in height sprayed with fifty per cent. kerosene and water March 3rd, 1898. About two quarts of material used. Tree made fairly good growth early in the summer, and has not been much injured. No living scale has been found.

No. 17. A plum tree about eight feet in height sprayed as No. 16, with fifty per cent. kerosene and water, on same date. This tree made a fair growth early in May; but the leaves shriveled and dried up in June. The effect was about the same as when pure kerosene was used.

No. 18. Two apple trees about seven feet in height sprayed with 40 per cent. kerosene March 3rd. Foliage not hurt and the trees have made a good growth. No living scales have been detected to June 1st.

No. 19. A plum tree at Annapolis Junction, about the same size as the apples used in No. 18 sprayed March 17th with 50 per cent. kerosene and water. An examination April 15th shows that the foliage has not been hurt. No living scale found. May 10th, foliage in good condition. A microscopic examination of five hundred scales shows not one alive. May 26th, an examination of the tree shows the foliage in good condition. No living scale found.

GASOLENE.

In March, 1898, I began an experiment at Annapolis Junction with pure gasolene to test the effect of the substance upon the San Jose scale and the physiological effect upon the opening buds.

Two Abundance plum trees badly infested with the scale were selected and sprayed as follows:

No. 1. Abundance plum about ten feet high with buds just unfolding spraying March 17th, 1898, with 3 quarts pure gasolene; the spray was directed from three sides, and the tree thoroughly covered.

No. 2. Abundance plum about same size as the preceding, sprayed with 3 quarts of a 50 per cent. solution of gasolene and water.

An examination of twigs cut from these trees May 14th showed that 62 per cent. were living on No. 1 and 78 per cent. on No. 2. The foliage and buds were not damaged. These trees were sprayed with 20 per cent. solution of kerosene and water May 26th; but young larvae were found crawling June 7th and both trees fumigated with hydrocyanic acid gas June 8th for ten minutes which was not long enough, and again June 16th for thirty minutes. No living scale could be found upon twigs examined June 29th.

From this one experiment it would appear that gasolene pure and diluted can be used upon plums when buds are opening without injury to the tree, but that it destroys a very small percentage of the scale.

NURSERY INTERESTS IN MARYLAND.

It has been part of my official duty as State Entomologist to inspect the nurseries of Maryland, paying especial attention to the general healthfulness of the stock grown in them each season. In every instance, where we have found anything, whether it was insect or disease, which we considered dangerous and injurious in the nursery and orchard, we have put forth every effort to subdue it, and when necessary, have destroyed the trees to accomplish that end.

It is due to our nurserymen that I should say in this place that they have done everything possible on their part to co-operate with me in this work, and many of them have rendered me much personal and valuable assistance. Several insects and diseases of a very serious nature have been detected in large blocks of nursery stock, and in some instances, it has necessitated the destruction of entire blocks; while others have been saved by the application of well known remedies, depending of course, upon the nature of the attack. In every instance where the San Jose scale was found we have had the trees destroyed by burning.

The nurseries, on the whole, are at present in fine condition and growing a beautiful lot of stock. I can see a marked improvement in two years in methods of culture and care in the selection of lands adapted to the growth of young trees.

We have within Maryland 41 nurseries, and a number of small concerns which we have not included in our list. These nurseries had for their fall of '97 and spring of '98 trade, 3,773,845 fruit trees, and 1,221,750 ornamental and miscellaneous plants, of smaller fruits 20,478,075, making a total of 25,888,670. This does not include asparagus roots, of which there were 1,000,300. In these nurseries, there were 2,952,750 peach and 264,000 June buds, 759,300 apple, 94,100 pear, 169,680 plum, 5,100 June buds; 26,525 cherry; 7,390 quince; 331,750 ornamentals; 890,350 miscellaneous stock; 19,178 strawberries; 17,350 currants; 706,300 pears; 312,600 raspberries; 197,900 grapes and 65,925 gooseberries.

In this connection it is also interesting to note that these same nurseries have for sale this fall, (1898), and next spring 5,148,350 trees. Of these, 3,667,500 are peach, 700,050 apple, 80,200 pear, 24,500 plum, 40,000 cherry, 4,750 quince, 151,350 ornamentals and 480.000 miscellaneous trees. Aside from these, there are over 22,000,000 plants of small fruits, including strawberries, grapes, raspberries, blackberries, currants, and gooseberries. These figures do not include asparagus roots, of which there are more than 1,000,000 grown and sold annually.

All the nurseries in this state are now under the immediate supervision of the State Entomologist and State Pathologist and are inspected every six months in accordance with the new law passed at the last session of the General Assembly. (Laws 1898, Chapter 289). By this system of semi-annual inspection and the fumigation of all buds and trees grown or handled, the nurserymen of this state can give their customers a guarantee not given by any other state.

Originally, five nurseries in the state were found infested with the San Jose scale, and by the prompt and immediate destruction of all the infested trees, and a careful suppervision of all the stock handled since then, we have completely suppressed it. This was accomplished, however, only by the hearty and cheerful cooperation I received from the nurserymen themselves. By the total destruction of nearly 38,000 trees in two years, we do not now fear the San Jose scale in our nurseries, for we intend to keep them free from it in the future by constant fumigation and semi-annual inspection.

We will not accept trees or buds from any source outside the state unless they are accompanied with the proper certificate of inspection. The scale is so widely distributed and has been found in so many nurseries, we believe this is the only policy we can pursue at present. In Virginia, according to Prof. W. B. Allwood, State Inspector (First Ann Rept. 1896-97, pp. 11 and 12), the San Jose scale has been found in nurseries out of 35 inspected. This, so far as I am aware, is the largest proportion of infested nurseries in any state inspected up to the present time. It is reasonable to suppose, that the scale exists in many nurseries, unbeknown to the nurseryman, in states where inspection laws are not in vogue, and for this reason we must have the right to inspect, condemn or destroy trees coming from doubtful sources, as this is our only means of security.

I append herewith a list of our nurserymen, indicating the specialties of each:

MARYLAND NURSERYMEN.

W. F. Allen, Salisbury, Wicomico county. Specialty, strawberries and blackberries; one of the largest growers of these plants in the state.

E. A. Bageley, Bageley, Harford county. Dealer in general nursery stock.

Geo. Balderson, Colora, Cecil county. General dealer.

John S. Barnhart, Denton, Caroline county. General Dealer. Specialties, peach, plum, and grapes; the largest grape grower in Maryland.

William Corse & Sons, Baltimore. General dealers; Specialty, ornamentals, peach, plum, pear and apple.

F. T. Covey, Catonsville, Baltimore county. General dealer; specialty, ornamentals, grows no fruit trees.

Franklin Davis Nursery Company, Baltimore. General dealers; the largest individual growers of nursery stock in the state; specialties, apple, peach, pear, plum, ornamental and strawberries.

Samuel H. Dayhoff, Ringgold, Washington county. Small grower of peach, plum and quince.

Thomas F. Diffendal, Smithburgh, Washington county. Specialty, peach; grows also apple, pear and plum.

Fleming & Hetzer, Williamsport, Washington county. General dealers, growing small lots of peach, apple, pear, quince, and ornamentals.

E. Fogle, Philo, Washington county. Specialty, strawberries.

Robert L. Gulick, East New Market, Dorchester county. Specialties, strawberries, blackberries and grapes. Has extensive variety tests.

J. W. Hall, Marion Station, Somerset county. Specialties, strawberries, blackberries and raspberries.

J. G. Harrison & Sons, Berlin, Worcester county. These gentlemen are the largest peach growers in the state, and rank second as strawberry growers. They are also general dealers in other nursery stock.

John Hoover, Cavetown, Washington county. Small grower of peach and plum.

Horticultural Supply Company, Mountain Lake Park, Garrett county. Small growers of apple, pear, plum and ornamentals.

Chas. E. Jarrell & Son, Hillsboro, Caroline county. Growers of general nursery stock; specialties, peach and plum.

Charles W. Johnson, Ellerton, Frederick county. Small growers of peach, apple and quince.

J. W. Kerr, Denton, Caroline county. Grower of general nursery stock; specialties, plum, peach and apple. Mr. Kerr is considered our best authority on plum, and has one of the largest experimental test orchards of the various varieties of plums in this country, if not in the world.

Daniel Krouse, Wolfsville, Washington county. General grower; specialty, peach.

J. S. Linthicum, Wellhams, Anne Arundel county. General grower of small fruits; specialties, strawberries, blackberries and raspberry. The most extensive grower of raspberries in the state.

Wm. McBride, Vienna, Dorchester county. Grower of general nursery stock.

Theo. J. Myers, Pleasant Valley, Carroll county. Small grower of apple.

W. E. Myers, Hanesville, Kent county. Small grower of peach and plum.

R. G. Nicholson, Chestertown, Kent county. General grower of nursery stock; specialty, peach; large grower

W. M. Peters' Sons, Wesley and Ironshire, Worcester county. Very large growers of general nursery stock. These gentlemen are the second largest peach growers in the State, and are also very extensive strawberry growers.

J. C. Philips, Salisbury, Wicomico county. Small grower of strawbery and blackberry.

William Pritchard, Henderson, Caroline county. Small grower of peach.

B. C. Pullen, Church Hill, Queen Anne county. Small grower of peach.

J. A. Ramsburgh, Frederick county. Grower of general nursery stock; specialties, peach, apple and quince. Has the largest block of quince in the state, and second largest block of apple.

Chas. K. Shank, Smithburgh, Washington county. Small grower of peach, apple and pear.

Wm. M. Stevenson, Ringgold, Washington county. Small grower of peach, quince and small fruits.

E. Stoner, Westminster, Carroll county. Grower of general nursery stock; specialties, apple, peach, pear and ornamentals.

C. T. Sweet, Swanton, Garrett county. Small grower of apples, ornamentals and strawberries.

Hiram G. Tarbutton, Sudlersville, Queen Anne county. Small grower of peach.

C. Thayer, East New Market, Dorchester county. Small grower of strawberry and blackberry.

Richard Vincent, Jr. & Son, Whitemarsh, Baltimore county. Small growers of strawberry and blackberry; general dealer in ornamentals and vegetable plants.

M. B. Waite, Arundel, Anne Arundel county. Grower of general nursery stock. Specialty, peach, pear and apple.

H. J. White, Poolesville, Montgomery county. General grower of nursery stock; specialties, peach, apple, pear and strawberry.

H. B. Witter, Frederick, Frederick county. General grower, specialty, peach, apple and plum.

W. J. Woolen, East New Market, Dorchester county. Small grower peach, apple, and gooseberry.

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PUBLICATION

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Maryland Agricultural Experiment Station.

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(Only the bulletins named below are available for distribution.)

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“	“	5,	June,	1889,	Horticultural Department and Field Experiments.
“	“	6,	Sept.,	1889,	Commercial Fertilizers.
“	“	12,	March,	1891.	Pig Feeding.
“	“	22,	Sept.,	1893,	Steer Feeding; A Well Balanced vs. A Poorly Balanced Ration.
“	“	24,	Feb.,	1894,	Composition of Commercial Fertilizers sold in this State.
“	“	26,	June,	1894,	Tobacco.
“	“	27,	Aug.,	1894,	Composition of Commercial Fertilizers sold in this State.
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“	“	29,	Dec.,	1894,	Further Investigations on the Soils of Maryland.
“	“	31,	March,	1895,	Potato Experiments.
“	“	32,	April,	1895,	The San Jose Scale.
“	“	33,	April,	1895,	Horticultural and Agricultural Departments; Small Fruits Vegetables and Field Corn.
“	“	34,	July,	1895,	Composition of Commercial Fertilizers sold in this State.
“	“	35,	Sept.,	1895,	Wheat, Barley, Oats and Hay Experiments.
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“	“	37,	Feb.,	1896,	Composition of Commercial Fertilizers sold in this State.
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“	“	40,	Aug.,	1896,	Compositionof Commercial Fertilizers sold in this State.
“	“	41,	Sept.,	1896,	Tests of Methods of Preparing and Feeding Corn Fodder.
“	“	42,	Oct.,	1896,	The Maryland Trees and Nursery Stock Law and Other Information of Special Interest to Nurserymen and Fruit-growers.
“	“	43,	Dec.,	1896,	Report upon the Value of a New Corn Product.
“	“	46,	March,	1897,	Corn and Potato Experiments.
“	“	47,	June,	1897,	Dairy Farming.
“	“	48,	June,	1897,	Some Common Injurious Plant Lice with Suggestions for their Destruction.
“	“	49,	Aug.,	1897.	Composition of Commercial Fertilizers sold in this State.
“	“	50,	Sept.,	1897.	Rust and Leopard Spot, Two Dangerous Diseases of Asparagus.
“	“	51,	Dec.,	1897,	Horse-Feeding; Tests of the Digestibility of Oats, Corn, Hay and the New Corn Product.
“	“	52,	Feb.,	1898,	Composition of Commercial Fertilizers sold in this State.
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“	“	54,	March,	1898.	Tomatoes.
“	“	55,	May,	1898,	The Black Peach Aphis, Cut Worms in Young Tobacco—Law Providing for the Suppression and Control of Insect Pests and Plant Diseases in Maryland.
“	“	56,	June,	1898,	Wheat, Winter Oats, Barley and Lime Experiments.

The Hessian Fly AND Wheat Diseases.

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OF THE
MARYLAND AGRICULTURAL
EXPERIMENT STATION,
COLLEGE PARK, MD.
AUGUST, 1898.

THE
Maryland Agricultural Experiment Station.

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ADDRESS

AGRICULTURAL EXPERIMENT STATION,

College Park, Maryland.

THE MARYLAND
AGRICULTURAL EXPERIMENT STATION

BULLETIN No. 58. SEPTEMBER, 1898.

The Hessian Fly in Maryland.

By Willis G. Johnson, A. M., Entomologist.

INTRODUCTORY.

That delicate little insect, commonly called the Hessian fly, but known to science as *Cecidomyia destructor* Say, appeared in our wheat fields in such destructive numbers last fall and this spring, we have thought it wise to publish a brief, popular bulletin, giving the general public such information as is available, at the present time, for its suppression and control.

It is usually more or less abundant in certain sections of the state every year, but some seasons its attacks are far more serious than at other times. During the fall of 1896, I saw several fields of wheat in St. Mary's county that were quite badly infested; and in the fall of 1897, I noticed many fields in Western Maryland seriously damaged, some of them almost totally destroyed. In addition to our personal observations, we have collected much valuable information upon this topic from the farmers themselves through a circular of inquiry. These reports represent every section of the state, and indicate that the insect has been unusually abundant this year. As many inquiries have been made regarding its life history and habits, I will give a short account of its importance, origin, distribution, and transformations.

IMPORTANCE.

The Hessian fly is regarded as one of the most destructive of all our injurious insects, especially, from the fact, that it attacks our most important cereal crop. The minimum annual loss to the growers in wheat producing sections of the United States by this pest is estimated at over 40,000,000 bushels; or in other words, about 10 per cent. of the crop. Some seasons, the ravages are much worse than others, and it is not an uncommon thing to find local losses amounting to fully 50 per cent. or more; and sometimes total failure. In Maryland alone, the wheat crop has been short about one-quarter this year and I estimate that one-fourth of this is due to the Hessian fly. In other words the loss to the farmers is about $750,000.00 from this one insect.

DISTRIBUTION.

The Hessian fly is now thoroughly established in the entire wheat-growing belt of the United States and Canada. It is an imported insect and is supposed to have been introduced in straw brought over with the Hessian troops during the war of the Revolution, as it became very injurious on Long Island three years later, that is 1779, in the vicinity of the place where the troops landed. The spread of the insect has been slow, but gradual, reaching the Pacific coast about 1884. In Europe, the wheat belt from Russia eastward has long suffered from its attacks. It appeared in England in 1886, and was observed in new Zealand in 1888, where it has since occasioned much injury. It will thus be seen that it has nearly completed its circuit of the globe.

ITS APPEARANCE IN MARYLAND.

The Hessian fly made its first appearance in Maryland fourteen years after the landing of the Hessian troops in 1776, so far as I can ascertain from available published records. It does not seem to have attracted much attention in this state from 1790 to the year 1817, at which time it was very abundant, and "in parts of Maryland and Virginia was perhaps more destructive than it had ever been before." It appeared more or less abundant in 1820, 1830, 1832, 1836, 1840, and each succeeding year to 1843, when "in the central parts of Maryland the crops in many instances, were rendered totally worthless." The following year, 1846, Fitch says, speaking about this insect in Maryland, "so great ravages have not been committed by the Hessian fly since 1817. On some of the best land wheat has been plowed up, and other portions are so much injured they will not be worth harvesting." For the next twenty years the fly attracted very little attention in Maryland and it was not until 1866 that any serious damage was recorded. There was a period of comparative immunity between 1866 and 1871. From this latter date, the pest was quite conspicuous each season to 1874. The following year, 1875, little damage was done, but in 1876, the insect was more abundant. It next appeared in 1879 and 1880, and again in 1882. From 1882 to 1896 it was more or less abundant in local fields, here and there, but not until 1897 was there a universal complaint regarding its ravages. It has been reported to me from nearly every county in the state.

The Hessian fly is an exceedingly delicate, two-winged insect, very much resembling a gnat or mosquito in general appearance, being only one-tenth of an inch in length. On account of its smallness it is very rarely ever seen by the average wheat grower, and I have thought it wise, therefore, to produce the accompanying illustration giving its various stages. It must be remembered that the male and female represented at *f* and *g*, have been greatly enlarged. An insect natural size, is seen at *e*, upon the leaf depositing its eggs.

DESCRIPTION AND LIFE HISTORY.

The Female:—The body of the female (Fig. 27, *f*.) is quite slender and dark brown. It has a round, somewhat flattened head; the eyes are black, the wings uniformly dull, smoky brown, while the legs are paler than the rest of the body. The abdomen is rather full, with segments distinct. As noted above, the length of the fly is about 2.5 millimeters, or about one-tenth of an inch.

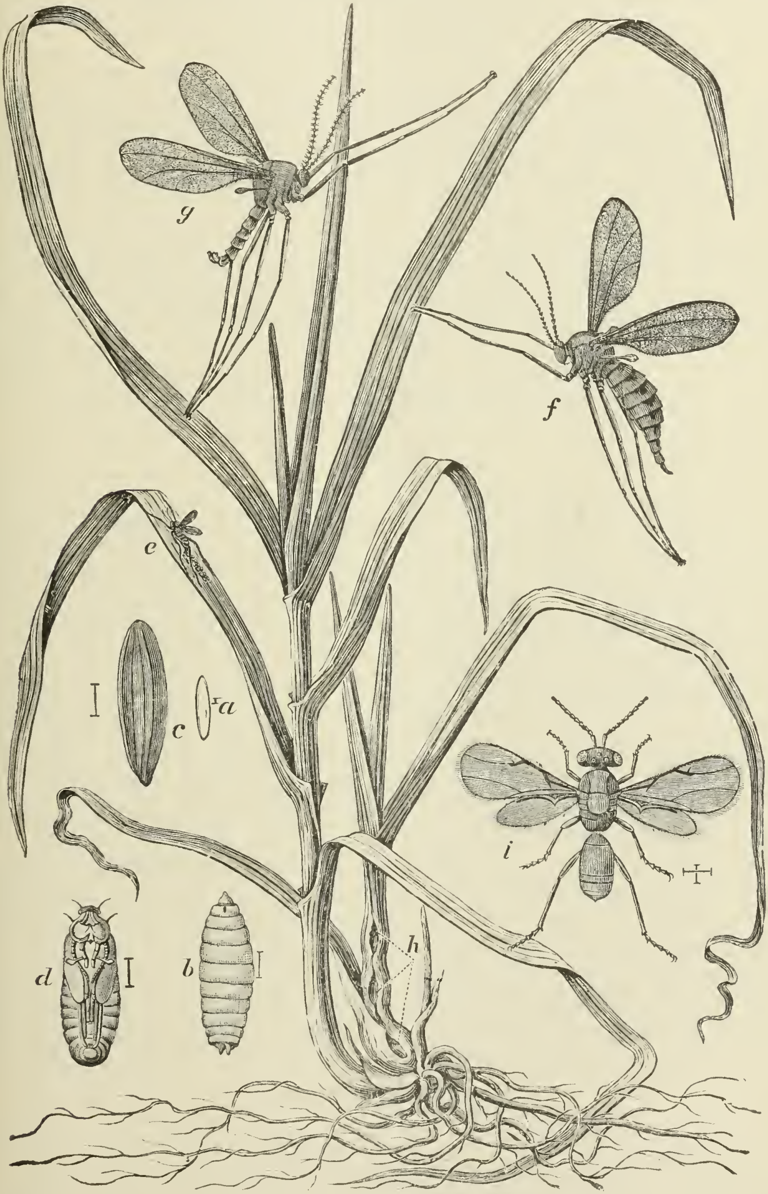

Fig. 27. The Hessian fly and its various stages of development: *a*, an egg much enlarged; *b*, larva or worm enlarged; *c*, flaxseed; *d*, pupa; *e*, adult, natural size, laying eggs; *f*, female, much enlarged; *g*, male, greatly enlarged; *h*, stalk of wheat showing attack; *i*, natural enemy or parasite. (After Packard, Third Rept. Ent. Com.)

The Male:—The male as, shown at *g*, greatly enlarged, is smaller than the female, being easily distinguished by its long, slender abdomen, and its longer and more hairy antennae or feelers.

The Egg:—The egg, as seen at *a*, greatly enlarged, is very minute, being only one-fiftieth of an inch long, cylindrical, pointed at each end, shell shiny and pale red when the young is nearly matured, but lighter at first.

The Larva:—The larva or worm, see *b*, emerges from the egg about four days after it is laid. The time of emerging, however, depending somewhat upon the weather conditions. When mature, the larva is a small, smooth, shining, and oval cylindrical creature, being about fifteen-hundredths of an inch long, with a width of about six-hundredths of an inch.

The Flaxseed:—When the larva becomes full grown it transforms into what is known as the pupae stage. The body turns brown, and finally a bright, chestnut color, becoming somewhat spindle-shape in form, a little larger than the larva, as shown in the illustration at *c*. The hair lines at the sides of the figures indicate the natural size. The form is known as the flaxseed stage on account of its close resemblance to a flaxseed. It is in this condition that the insect remains, transforming to the true pupae, from which the adult finally emerges.

HABITS.

There but two broods of the Hessian fly over a large area of the United States, one appearing in the spring and the other in the fall. There is no question of doubt, however, about there being supplemental broods, both in the spring and fall, particularly in the southern wheat area. In the extreme northern belt, where spring wheat is largely grown, there may be only a single brood.

The flaxseeds that have passed the winter in the fall-wheat produce the winged individuals which appear in the spring during April and May, more abundantly about the middle of the latter month. The eggs are deposited usually on the upper surface of the leaf. With the spring brood however, they are sometimes thrust beneath the leaf sheath on the lower joints. A single female produces from 100 to 150 eggs and they are deposited in irregular rows of from 3 to 5 or more.

Hatching from the eggs the young larvae imbed themselves beneath the sheath and stem causing a more or less distorted plant. The spring brood usually develops in the lower joints near the ground. Under certain conditions the insect may remain dormant in the flaxseed state for a year or more and still bring forth the adult. This is, without doubt, a provision of nature intended to prevent accidental extermination of the species. The migrating brood is the one which appears in the fall; the spring brood does not usually leave the field in which it is developed.

EFFECTS IN WHEAT.

The very dark, green color and the tendency of the wheat to stool, are the first indications of the presence of this insect in the fall. At first glance one would think the wheat was exceptionally healthy. A closer examination, however, shows that the leaves are broader, and that the upright central stems are wanting. Shortly afterward the infested plants turn yellow or brown and die in part or altogether. In badly infested fields, the spring brood attacks the laterals, dwarfing and weakening the plant to such an extent, that it falls readily and cannot be harvested.

NATURAL ENEMIES.

The Hessian fly is attacked by several natural enemies. They are very minute, four-winged creatures and develop within the larvae and pupae. One of them is shown in the illustration at *i*. We have in America, several native species of these parasites, while in Europe there are many more, one of which the Division of Entomology, United States Department of Agriculture has attempted to introduce and colonize in this country. It was successfully imported and was liberated at various places in several states, one distribution having been made near Ceciltown, Cecil county, this state. We cannot expect any direct relief from these parasites as they are effective only in a limited way and under most favorable conditions.

PREVENTION AND REMEDIAL MEASURES.

When a field has once been badly attacked it is next to worthless. Pasturing the early sown wheat in the fall has been recommended and has resulted in much good. The remedies are mainly along the line of farm management, and require much study for various localities.

Late Planting:—After considering the data now in hand, I have concluded to divide the state into three sections, (1) the northern, (2) the central, and (3) the southern, as the time for seeding to avoid the fly varies slightly in each. In the northern section, which includes Garrett, Allegany, Washington, Frederick, Carroll, Harford, Cecil and Baltimore counties, wheat sown between September 28th and October 8th, have produced the best crops and have been less attacked by fly than wheat sown earlier.

The central section, including Montgomery, Howard, upper Prince George and Anne Arundel, Queen Anne and Kent, the most favorable time for planting is from October 1st to 15th.

The southern section includes lower Prince George and Anne Arundel, Charles, St. Mary's, Calvert, Talbot, Dorchester, Caroline, Somerset, Wicomico and Worcester counties, and the period here is from October 5th to 20th.

It must be understood that these dates do not always represent the safety limit, as the weather conditions and seasons have very great bearing on this subject. Elevation is also an important factor. Some years the very latest wheat sown is attacked, but this is not the case very often. The majority of instances favor the dates above given.

Turning Stubble:—Where it is customary to follow wheat on wheat, the stubble should be plowed down just as soon as possible. I do not advise burning over stubble fields.

Rotation of Crops:—The rotation of rops has a great tendency to keep the fly in check, and the value of this system has been many times demonstrated.

Trap or Decoy Crops:—The planting of trap or decoy crops was among the earliest suggestions, and is practiced with gratifying success. Stripes of wheat are sown very early, into which the flies are decoyed where they deposited their eggs. The wheat is then turned deeply under the ground.

Volunteer Wheat:—Volunteer wheat should be destroyed by plowing under or mowing or burning as soon as possible.

It is the purpose of the author to give a more exhaustive account of this insect in his next annual report.

NOTICE.

It is my desire to keep thoroughly in touch with every part of the state, and whenever any insect appears in destructive numbers, I will greatly appreciate it, if specimens are sent immediately to my office for determination. Whenever the interest warrants it, I will make an immediate investigation, advise and assist in the destruction and control of the pest under consideration.

Insects of any kind, including caterpillars or worms, will reach me safely through the mail, if enclosed in a small, pasteboard or wooden box. It is not necessary to perforate the box, as insects do not require much air when sent in this manner. If the farmers of the state would promptly notify me of any local insect outbreak, whenever one occurs, very often many hundreds of dollars could be saved, and a general attack averted. You can have the benefit of our experience by simply asking for it.

SOME IMPORTANT WHEAT DISEASES.

BY CHARLES O. TOWNSEND, PH. D., PLANT PATHOLOGIST.

INTRODUCTORY.

Owing to the fact that the wheat crop harvested in Maryland during the past season was seriously damaged in several sections of the State by various plant diseases, it has been considered advisable to issue a preliminary bulletin, reviewing briefly the nature of these diseases and the means of preventing them. According to the official report for 1897, the State of Maryland produced 12,277,056 bushels of wheat from 639,430 acres. This crop was valued at $11,500,000. The yield for the present season is about one-quarter less than that of last year, which means a loss to the State of nearly $3,000,000. Hence the importance of combating the various diseases and insects, which are in a large measure responsible for this reduction.

The necessity of calling the attention of wheat growers to the disease of this cereal at this time becomes more apparent when it is remembered that several diseases which tend to injure the quality and to reduce the quantity of the grain can be successfully treated only before the seed is sown.

A disease may be produced wholly or in part by unfavorable conditions of climate or of soil While it is impossible to control the former, it should be the first object of the wheat grower to see that his ground is in the best possible condition, not only from the stand point of cultivation, but also in regard to the proper supply of food material. Every unfavorable condition tends not only to reduce the quality and yield of the grain, but it also tends to render the plants more susceptible to other diseases and thereby to injure still further the quality and quantity of the grain produced.

FUNGOUS DISEASES.

Wheat is subject to several fungous diseases, most of which have often been described by other writers, but which evidently have not received serious attention on the part of wheat growers, at least in the application of the preventives. The most common fungous diseases are usually designated as smuts and rusts.

Smuts:—There are several varieties of smuts that often cause the destruction of more or less of the wheat crop. These smuts are commonly known as "Bunts" or Stinking Smut and Loose Smut. Two varieties of the former are often found in wheat fields. Sometimes they are both found in the same field; sometimes only one is present. These species, known as *Tilletia Tritici* and *Tilletia foetens*, are distinguished by the microscopical appearance of the spores. In the former, the outer wall of the spores is covered with a series of ridges, giving the coverings of the spores a net-like appearance, while the latter are covered with a smooth outer wall. It should also be noted that the spores of the latter are more elliptical in shape than the former. The smut spores cling to the grains of wheat, and are therefore sown with the wheat. When the wheat grains germinate the spores germinate also and the fine tubes which are produced by the germination of the spores and which make up the fungus penetrate the tissues of the seedling, and thus the two plants grow, one within the other. By the time the wheat plant has become full grown, and has begun to form its head, the smut plant has grown up through the stem, so that when the grains begin to form, the thread like structures of the fungus push directly into the kernel, where it forms its new spores. These spores increase in size, causing the diseased kernels to become much larger than the healthy ones, thus giving to the whole head a swollen appearance. The diseased heads have also a brown or grayish color, instead of the characteristic yellowish tinge of the normal heads. It is often the case that this disease is not observed in the field, but if close examination is made at the time of ripening of the heads, the diseased grains, if present, may be detected by crushing, when it is found that the grains are made up largely of a brownish powder (the spores) which emit a disagreeable odor. It is evident that all heads filled with the smut are worthless and worse than worthless, since they not only reduce the yield of wheat, but also furnish the spores for the perpetuation of the pest. The loose smut (*Ustilago Tritici*) attacks the young wheat plants in the same manner as do the stinking smuts, the spores in this, as in the preceding case, often being sown with the grain. The fungus also spends its existence within the body of the host plant; its spore formation, however, is not confined to the grains, but appears in all parts of the head, apparently transforming the head into a loose, powdery mass. This disease is readily recognized before the grain is ripe, but as a rule it is not nearly so destructive as the stinking smuts. The spores often ripen and are blown away before the grain is ready to be harvested, so that at harvest time the field may seem to be almost or quite free from loose smut. By looking closely, however, the headless straws may be seen, showing where and to what extent the fungus has done its destructive work.

PREVENTIVE.

Since these disease-producing fungi spend their existence within the host plant, it is evident that the remedy must be preventive rather than curative, since any application which would destroy the life of the fungus would also tend to injure or destroy the life of the host plant. Hence, the simplest method of preventing the disease is to destroy the spores before they begin to germinate. For this purpose several methods have been employed with success, especially with the stinking smuts.

*Hot Water Method:**—It has been found by experiment that it is possible to destroy the vitality of the spores which cling to the wheat grains without destroying the germinating power of the grains themselves. Indeed, the grains which are treated with hot water tend to germinate more readily than do untreated grains, a condition, which in itself tends to prevent the action of the smut. The method of treating wheat with hot water has been given at length by Swingle** and others, and should be carried on as follows: Fill two large kettles with water, and heat the water to 110 degrees F. in one kettle and 132 degrees F. in the other. Place the wheat to be treated in a sack or basket and dip it into the first kettle until the grain is warmed, then plunge it for fifteen minutes into the second kettle. In both cases, the grain should be agitated by lifting and plunging into the kettle, or otherwise, so as to bring the surface of each grain into contact with the hot water. This is facilitated if the sack or basket is only partly filled with grain. Care should be taken that the temperature of the water in the second kettle does not rise above 135 degrees, as that temperature is liable to injure the germinating power of the grain. If the temperature of the water rises above 132 degrees, the time of treatment should be reduced, e. g. at 135 degrees the grain should not be immersed for more than five minutes. If the temperature of the water falls below 132 degrees the time for immersion should be increased. In no case should the temperature be allowed to fall below 130 degrees, since the smut spores are liable to resist a lower degree of heat. The best method for retaining the proper temperature of the water is by the addition of hot or cold water as the case requires. As soon as the grain has been treated with hot water, it should be spread on a *clean surface* to dry.

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*Jensen, Ueber die Verhuting des Kornbrandes. 1890.

**Farmers' Bulletin, No. 75, U. S. Dept. of Agr. 1898.

The spores of loose smut seem to be a little more resistant than those of the stinking smut, for which reason a slight modification of the above treatment is recommended as follows: Soak the grain for four hours in cold water and set away in wet sacks for about four hours more. This renders the spores and also the grain less resistant to the action of the hot water, for which reason, the grain should now be submerged but five minutes at 132 degrees. Even this treatment will destroy the germinating power of some of the grains, which makes it necessary to sow about one-half more seed per acre. The grain may be treated according to the above directions at any time before seeding, i. e. several weeks or even months before it is to be sown, providing it is kept in a clean place until ready for use. If the grain is to be sown with a drill, it must be thoroughly dry, but if it is to be sown broadcast, a little dampness will do no harm.

Other Preventives:—Other methods for preventing grain smuts have been discovered from time to time. One form of treatment which has received considerable attention, and which has been very successful, especially with stinking smuts, consists in soaking the grain for several hours in a solution of copper sulfate. A one-half per cent. solution, in which the grain is soaked for twelve hours seems to be most effectual. Solutions of arsenic, lime, salt, and other substances have been tested with more or less satisfactory results. To these methods may be added the simple process of washing the grain with pure water, which results in removing more or less of the smut spores from the grains. The effect of various methods of applying heat, e. g. dry heat, moist heat, heated air, etc., have been investigated, and have been found to be in a measure successful, although the hot water method is considered on the whole most effectual.

RUSTS

Rust often makes its appearance on the leaves of wheat plants, and may be recognized by the yellowish streaks and patches which it forms. The spores of the fungus are carried by the wind and lodged on the leaves and straws, where they germinate and send their thread-like structures into the tissue of the wheat plants, from which they draw nourishment for their own growth and development. The germination of these spores is greatly facilitated by the presence of moisture and heat, hence we find the rusts worse during moist, hot seasons. The fungus plants produced by the germination of rust spores do not attack the grain directly, but they draw so much nourishment from the straw and foliage that the grains are unable to develop, and therefore, present a shrivelled appearance when ripe. The yellowish streaks and patches are masses of spores which may be blown on to adjacent wheat plants, and thus the disease may spread from plant to plant until whole fields are affected. As the season advances, the yellowish streaks and patches give place to a darker color, due to the formation of other spores, known as winter spores. These differ from the former, in having thicker, darker walls, in being composed of two parts (cells), and in their ability to retain their vitality through the winter.

Remedy:—Since the spores that produce this disease are not sown with the grain, it is useless to treat the seed itself for the disease. Many attempts to spray the fields of grain with different fungicides for the prevention of rust have been made but so far the efforts in this direction have given very little satisfaction. In as much as this disease usually appears rather late in the season, it has been suggested that those varieties be grown that ripen early. This will prevent in a large measure the destructive action of rust. It should also be borne in mind that certain varieties, e. g. the red wheats, are more resistant to rust than others, although it appears that no variety is rust proof. Also the varieties with thicker or tougher skins are less liable to be infected with rust. Since it is evident that the winter spores remain on the stubble during the winter, a crop that has been infested with rust should not be followed immediately by another grain crop. Usually, an interval of one year is sufficient to destroy the spores. In the rotation of crops it should be remembered that rusts will live upon grasses as well as upon wheat. If circumstances are such that it is necessary that a grain crop should follow a grain crop which was infested with rust, the stubble should be burned, in order to destroy the rust spores.

SEPTORIA.

During the past season the wheat crop in certain sections of our State has been greatly injured by another fungus, a species of Septoria (probably *Septoria glumarium*). It does not appear that this fungus has heretofore produced any damage to wheat in this State, although it has been seen in Europe and possibly in some parts of our own country. I have not been able, however, to find any account of its appearance in America. It is seen soon after the heads are formed, and attacks the straw, leaves and glumes, but does not attack the grain itself. It spreads rapidly over the individual plants, and from plant to plant, and draws so much nourishment from its host just at the time when the heads are filling, that the kernels are very much shrivelled. It often appears most distinctly upon the heads, giving them a dirty appearance. Upon close examination, the infested parts are seen to be covered with numerous, small, black dots which are masses of spores in little cavities (Pycnidia.) It is impossible to estimate at this time, the amount of damage done by this fungus during the past season, but in a single instance, one field that gave every indication of producing from 30 to 35 bushels per acre of A No. 1 wheat was so injured in a few days by this pest that the yield was reduced to 15 bushels per acre of inferior grain. In other sections the degree of injury has been more or less marked. It has been impossible to investigate the disease fully during the past season. If it appears next year, it will receive special attention, the results of which will be published in another bulletin.

It is probable that the suggestions given for the prevention of rusts will in a measure prevent the destructive action of this disease.

NOTICE.

In case any fungous disease makes its appearance in this state, I should be very glad to have specimens of the diseased parts of the plant sent to my address. This will enable me to know what disease we have to contend with, and where they are located. Such specimens may be enclosed in an envelop or box and sent by mail. If a remedy or prevention is known I shall take pleasure in sending directions for treating the disease, and if a remedy or preventive is not known it is important that the disease be brought to my attention in order that a means of combatting it may be found. Whenever the case demands it, I shall be glad to make a personal inspection of the diseased plants in the field or orchard.

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OF THE

Maryland Agricultural Experiment Station.

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BULLETIN No. 59

OF THE

MARYLAND AGRICULTURAL
EXPERIMENT STATION,

COLLEGE PARK, MD.

JANUARY, 1899.

THE
Maryland Agricultural Experiment Station.

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The Bulletins and reports of the Station will be mailed regularly, free of charge, to all residents of the State who request it.

ADDRESS:

AGRICULTURAL EXPERIMENT STATION,
College Park, Maryland.

THE MARYLAND
AGRICULTURAL EXPERIMENT STATION

BULLETIN No. 59. JANUARY, 1899.

SWEET POTATO INSECTS.

By E. Dwight Sanderson, B. S. A., Assistant Entomologist.

SWEET POTATOES are one of the most important crops of the Southern counties of Maryland on the Eastern Shore of the Chesapeake Bay, as well as of Anne Arundel county on the Western. Out of a total yield of 44,000,000 bushels from eighteen states in 1890, the census quoted Maryland with only 408,000 bushels. Recent crop reports, however, estimate a yield of 2,000,000 bushels for the Maryland-Virginia peninsula. Baltimore, doubtless, stands next to New York as a sweet potato market, and about one-half the Maryland crop is shipped there; however, through the opening up of the other markets, this industry has received somewhat of a stimulus in the last few years.

The sweet potato market is one which pays well for the early crop, but is always glutted at the height of the season. This year it opened at $5.00 to $6.00 per barrel, but when the whole crop commenced to come in during October, the price sank to as low as 25 to 35 cents.

Injurious insects (Flea Beetles, Tortoise Beetles and Cut Worms), which so damage the newly set plants as to seriously stunt their growth, and thus prevent early maturity of the tubers, are thus one of the most important factors opposing profitable sweet potato culture. And not only do they prevent an early crop, but the damage done to the young vines seriously curtails the late crops.

A plot of sweet potatoes for testing the varieties, planted by Prof. J. S. Robinson at this Station, was observed to be more or less badly injured by Flea Beetles and Tortoise Beetles soon after being set out. One row of Early Rivers was so badly eaten that it was taken up and planted in Big Stem. Notes taken on June 1st, 1898 were as follows:

Big Stem:—Older leaves are badly eaten, but are tough, and plants are recovering from injury, sending out new leaves.

Jersey Red:—Plants seem to have been attacked when very young and have been badly stunted. Some are entirely stripped of foliage.

Paragon:—Not so badly injured as Jersey Red. Are making good growth now that beetles have gone, before the eggs hatch.

Early Rivers:—Plants very badly eaten. Large part of rows killed by beetles.

After these varieties were planted, there ensued a most prolonged drought until about the 12th of August, which only tended to render more apparent the injuries of the beetles. From May 19th to August 12th there was only about 2½ inches of rain fall, the most of this being a half-hour shower of 1¼ inches on July 16th. Subsequent to August 12th, there was an equally bad drought until Oct. 18th, during which time there was scarcely over one-half of an inch precipitation. The final yield from these rows is most interesting as corresponding exactly with the outlook indicated from the above notes, and has been kindly furnished me by Prof. Robinson. Upon one of these plots barn yard manure was used and on the other a commercial fertilizer

VARIETY.	Barn-Yard Manure.				Commercial Fertilizer.			
	GRADE.			Per Acre bus.	GRADE.			Per Acre bus.
	1st's lbs.	2d's lbs	Culls lbs.		1st's lbs.	2d's lbs.	Culls lbs.	
Big Stem	244	37	25	253	351	43	23	346
Paragon	114	31	12	164	147	37	27	175
Jersey Red	44	19	26	73	79	25	20	102
Early Rivers	9	6	15	25				

In considering the different injurious insects of this plant, I have grouped them according to the different parts of the plant attacked by them so that they may be more readily recognized by the reader, from the nature of the injury.

Feeding Upon The Tubers.

The Sweet Potato Root-Borer or Weevil.

(*Cylas formicarius*—Olivier.)

Though never reported from Maryland, this insect has sometimes nearly destroyed the crops of certain localities in Florida, Louisiana and Texas, often preventing the growth of the crop for a year or two, and Maryland growers should be on their guard against it in securing stock from those districts.

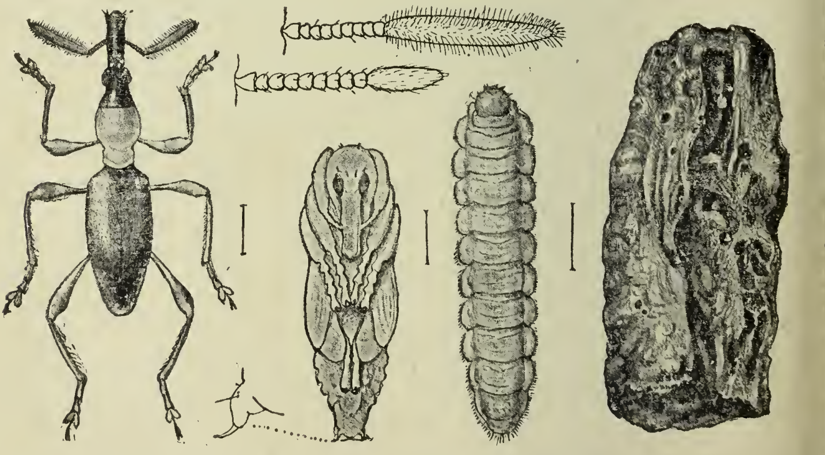

Figure 28.—The sweet-potato root borer (*Cylas formicarius*). Extreme left hand figure adult beetle, with enlarged antennæ at right. Figure at left center, pupa; at right centre, larva; at extreme right, portion of sweet-potato tuber channeled by borer. All figures except the last considerably enlarged; natural sizes indicated by hair lines. After Farmer's Bulletin, No. 26, U. S. Dept. Agr.

It is a cosmopolitan insect, being reported by Dr. J. H. Leconte from Cochin, China, India, Madagascar, Australia and Cuba, and recently by Prof. C. H. T. Townsend from Jamaica, where it was imported from Cuba. It was doubtless from Cuba that it was also imported into Louisiana, where it was first noticed in the vicinity of New Orleans in 1875 and has since spread North along the Mississippi River*

In 1879 it was reported from Florida and at that time was studied by Prof. J. H. Comstock, then U. S. Entomologist.*

From 1890 to 1892 it did very serious damage in Louisiana and Texas, but strangely, has not been reported as injurious elsewhere.

The beetle is a rather slender insect, and has received its specific name "formicarius" from its close resemblance to an ant. It is about one-fourth of an inch long, of a bluish black color, and with a reddish brown prothorax.

In the sub-tropical climate of these states, the insect seems to breed during the whole year, Prof. Comstock having observed three generations, and specimens then doing injury have been recorded at all seasons of the year.

The yellowish-white, oval eggs are deposited in small cavities eaten out by the mother beetle, either at the base of the vine or at the stem end of the tuberous root, and Prof. Morgan, (l. c.) records their being placed in the tubers.

The latter point is important, as showing that the insect might continue to breed after the potatoes had been dug and stored, and also the ease by which it might spread.

The small white grubs commence to burrow in the vine as soon as hatched and then descend to the tubers, which, in the course of the season, and by the aid of the beetles, they thoroughly riddle. The full grown larva is about the length of the beetle, the joints of the segments are strongly constricted and the legs are absent, being represented by mere tubercles.

The grub now forms a small cavity at the end of its burrow and transforms to the pupa. In this stage it remains from eight to fourteen days, when the adult beetle emerges and spends about six days in depositing eggs for another brood. Thus the whole life cycle requires from 35 to 39 days.

From the nature of the injury it is apparent that the only method of combatting this pest it to remove all small or badly infested tubers and feed them to hogs, and burn all the vines.

In receiving tubers from infested states, it would always be wise for more northern growers to fumigate them before planting. Carbon bisulphide has been successfully used for this and hydrocyanic acid gas, as used for fumigating nursery stock, would be entirely safe, if not used in too large a dose.

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*See Bul. No. 28 La. State Expt. Sta. (Baton Rouge), Report of the Entomologist, H. A. Morgan, P. 999 (1893).

*See Report U. S. Sec. Agr. 1879, P. 249.

Cutting the Stems.

Cutworms.

These inveterate enemies of the trucker, the Cutworms, do not usually fail to devote due attention to the young sweet potato plants when they are first set out and frequently their injuries are such as to make necessary considerable resetting. The rigor of their attack is doubtless due to the fact that sweet potatoes are usually planted on light soil which has no other covering than weeds and grass during winter and is cultivated for some little time before the plants are set out, thus thoroughly starving the cut worms and putting them in excellent condition for a hearty meal.

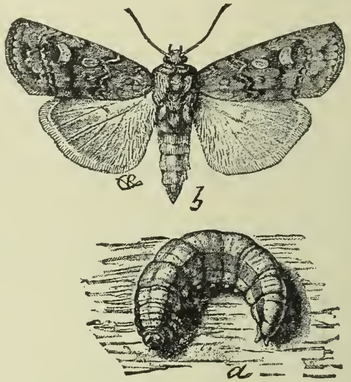

Figure 29.—The Dark-Sided Cutworm (*Agrotis messoria* Harr). a, larva; b, moth. (After Riley.)

Though many species injure the young plants by cutting the stems at the surface of the ground, the dark-sided cutworm (*Agrotis messoria* Harr.) has most often been recorded* as specially preferring them and an account of it will be more or less typical of all the nearly related species. Grass lands is the usual habitation of cut worms and here the eggs are deposited in late summer and hatch in a few days. The young worms eat rather sparingly, and are only partially developed by the first frosts, when they curl up under such shelter as is securable and hibernate during the winter. With the appearance of vegetation in the spring they revive and commence to eat voraciously. Thus, as already shown, if their only food plants are turned under and the ground cultivated before the potato plants are set, such a precedure only sharpens their already intense appetite. The larvae become full grown the latter part of May and enter the pupal stage, from which the adult moths emerge in July and August. Fortunately, there is but one brood of this species, but of many there are two.

Remedies.

If practicable, deep fall plowing will turn under large numbers of the young worms and thus destroy them. Otherwise, keep the land thoroughly cultivated in the spring, and about three or four days before setting out the plants, scatter over the field bunches of grass or clover from a plot which has been thoroughly sprayed before cutting with a mixture of one pound of Paris green to one hundred gallons of water. By placing these poisoned baits every fifteen to twenty feet apart, the cutworms will be lured out of the soil to a certain death and all will soon be found dead, about an inch below the surface.

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*Report N. J. Agr. Expt. 1892, P. 469, Dr. J. B. Smith.

If appearing late in the season, a mash composed of fifty pounds of wheat bran, one pound of Paris green and about two quarts of cheap molasses with just enough water to moisten it, will be found more convenient. A tablespoonful placed on the ground near the plants every 10 or 12 feet will be sufficient.

Eating the Leaves.

The Sweet Potato Flea Beetle.

(*Chaetocnema confinis* Cr.*)

As soon as the plants are set out, the leaves are often attacked by a small, brownish-black flea beetle. Small channels are eaten out in both surfaces of the leaf in a very characteristic manner, and often almost the whole surface is thus seared, but the leaf is never punctured. As a result, many of the leaves of the seedling are killed outright, turn brown, and decay, while a new growth puts out from below, thus often checking the growth of the young plant to a considerable extent, though never doing noticeable damage later in the season. Their attacks have been found to be worst on low land and that previously in sweet potatoes, and their work is always first noticed in that portion of a field nearest a fence, row or woodland where they have hibernated.

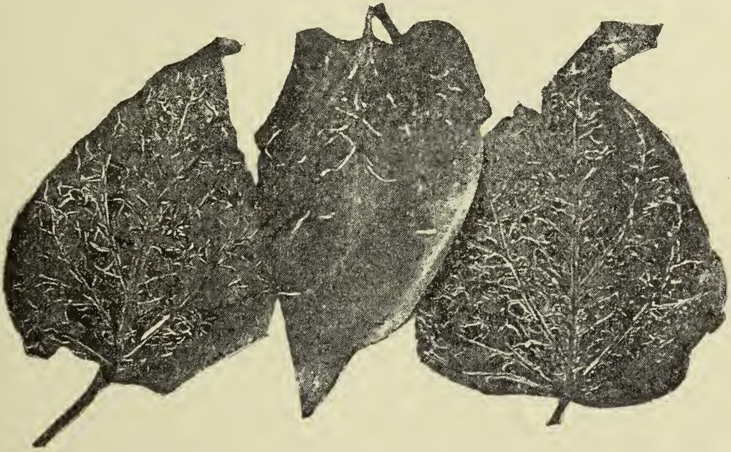

Figure 30.—Work of the sweet potato Flea Beetle (*Chaetocnema confinis Cr.*) (After Smith.)

Dr. J. B. Smith, of the New Jersey Agr. Exp. Station, has made many careful observations upon the work and habits of this insect (See Rept. N. J. Agr. Exp. Sta. 1892, Page 472.), but so far, has been unable to find any other stage than the beetle, and such has been the experience of the writer, even after the most diligent search. Evidently, like many of the flea beetles, the eggs are placed upon the roots of one of our common weeds, upon which the larvae feed.

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*(Syn.—Chaetocnema confinis Cr. C. flavicornis Lec.)

May 21st, 1892, Dr. Smith found the sexes copulating; on May 30th, the beetles were most numerous, and by June 13th, had begun to disappear. By July 1st, the beetles were entirely gone.*

On the vines at the Experiment Station the beetles were most numerous this year during the first week in June and were not to be found after July 1st.

Remedies.

Probably the easiest method of treating this pest, and which will also be of service in fighting the beetles next described, will be to dip the plants in a solution of arsenate of lead while setting them. This is rather a new insecticide, but one coming rapidly into favor, being both safe and cheap, costing somewhat less than the other arsenates.

Eleven ounces of acetate of lead and four ounces of arsenate of soda are dissolved in one hundred gallons of water. The substances combine and from a white precipitate which is the arsenate of lead and should be kept well stirred. Two quarts of glucose or molasses renders the mixtures much more adhesive. Smaller amounts may be used in like proportions or a strong stock solution made up and then diluted as needed for use. Arsenate of soda costs about 8 cents per pound and acetate of lead 14 cents.

A spray of Bordeaux mixture, if applied immediately after the plants are set out, will prove objectionable to the beetles and lessen their attack.

Tortoise Beetles.

Of all the insects affecting the sweet potato, the brilliant, little golden beetles belonging to the family Cassidae, which from the broad expansion of their thorax and wing covers, are fancied to resemble a tortoise, are the most common and are peculiar to it. They are beautiful little insects with a peculiar power of changing color, some of the species even appearing like drops of molten gold.

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*Collectors at Philadelphia have taken the beetles in July and August, and Mr. Wenzel has ascertained that they hibernate during winter.

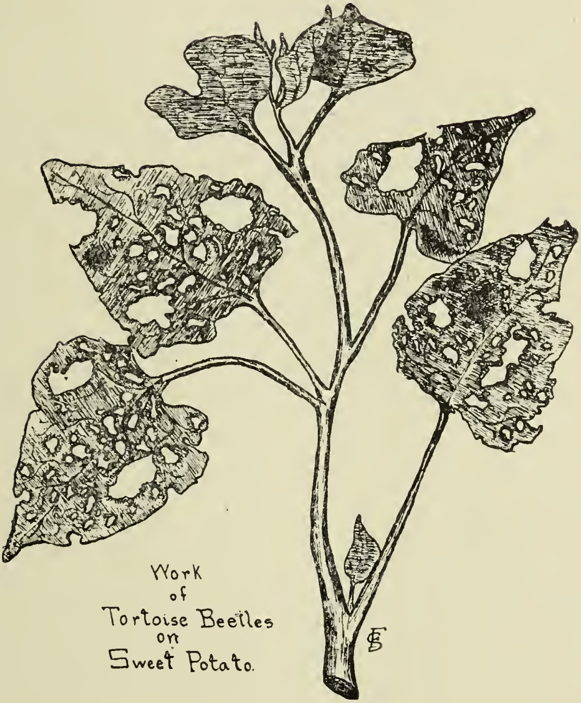

Figure 31.—Original (Drawn by Franklin Sherman, Jr)

The larvae of these beetles are, however, almost as disagreeable as the adults are attractive, but are nevertheless veryinteresting creatures. Each of them is provided with a tail-like fork at the end of the body which is almost as long as the body, and in those species in which it is depressed, entirely conceals the insect. Upon this fork is heaped the excrement and cast skins of the larvae, and when covered by this "umbrella," as it is often called, it is with great difficulty that the larvae is distinguished from a bit of mud or a bird dropping.

The manner in which this fork increases with the size of the insect is rather interesting. At each molt the faeci-fork of the last stage is held upon the faeci-fork of the new stage, and in this way the faeci-forks of all stages are telescoped, the one inside the other, as shown in figure 32, and the stage of the larvae may thus be readily determined. From the likeness of the burden on this fork to a pack, the larvae are often designated as "peddlers."

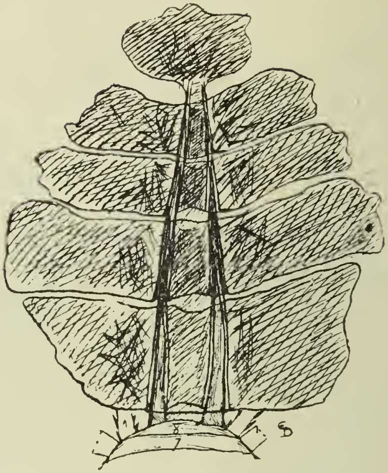

Figure 32.—Faeci-fork of larva of *Coptocycla bicolor F.*—(Original.)

The tortoise beetles affecting the sweet potato are distributed among three genera, but are sufficiently alike in their general habits and life history to be classed together in that respect. The beetles hibernate over winter, and in the spring before the potato plants are set, they feed on their native food plant, the morning glory.

As soon as the plants are set out, the beetles commence to eat large round holes in the leaves, and so riddle them that it is often necessary to replant. The worst damage, however, is done to the set, and on both the leaves and stem of it the eggs are laid. Very rarely have I found the new shoots eaten or eggs upon them, and this fact renders it much easier to spray for them, as at this time the plant has not yet commenced to run, and the older portion is still upright.

The larvae hatch during the first two weeks in June, and require slightly over two weeks to become full grown, there being five molts. Though the larvae also do considerable damage by eating the leaves of the plant, it is not nearly as serious as that done by the beetles and rarely becomes noticeable.

In order to more firmly bind the excrement and cast skins to the fork, the larvae fasten them together by a fine network of silken threads, which are then attached to the spines on the sides of the body. Just how this is done, I have not been able to determine, but am well satisfied that it is a fluid excretion from the vent, which hardens into fine threads upon exposure to the air. When fully grown, the larva fastens itself to a leaf by means of this excretion, its skin splits open along the back, and from it comes the pupa, which is held to the leaf by its caudal fork, being securely encased in the faeci-fork of the larval skin. About a week later the adult beetle emerges, eats for a few days and then disappears from the sweet potato patch until the following spring, and again feeding more or less on morning glory.

CASSIDAE.

Considerable variation exists in the life history of the various species at different latitudes, as may be seen from the following tables:

	Eggs Hatched.	Pupated.	Beetle Emerged
Ithaca, N. Y., bred by writer.	Colected larvae July 19th.	July 31st.	Aug. 8-9.
New Jersey by Dr. J. B. Smith,	June and July.	July 10th.	July 15-August.
College Park, Md., bred by the writer.	June 11th.	June 29th.	July5-9
Fort Collins, Colo., by C. F. Baker.	Larvae on June 2nd.	July 9th.	July 19th.

Coptocycla bicolor Fab.

College Park, Md., 1898. Hatched June 11th, Pupated June 29th, emerged July 5th.-9th.

Ithaca, N. Y., 1897. Larvae collected June 19th, Pupated July 30th, Emerged Aug. 8th-9th.

Coptocycla Signifera Fab.

College Park, Md., 1898. Hatched June 11th, Pupated June 27th, Emerged July 2nd-7th.

Ithaca, N. Y., 1897. Larvae July 19th, Pupated July 31st-August 5th, Emerged August 9th-14th.

Chelymorpha argus Licht.

College Park, Md., 1898. Hatched June 15th-19th, Pupated July 3rd, Emerged July 3rd-19th.

Ithaca, N. Y., from Newark, N. J., 1897. Larvae nearly grown July 18th, Pupated July 20th, Emerged July 29th.

Ithaca, N. Y., 1885. Eggs collected July 15th.

Cassida nigripes Oliv.

College Park, Md., 1898. Hatched June 15th, Pupated June 29th, Emerged July 12th.

Fort Collins, Colo. Larvae on July 2nd, Pupated July 9th, Emerged July 19th.

Cassida bivittata Say.

College Park, Md., 1898. Larvae June 29th, Beetles emerged July 5th-9th.

The Two-Striped Sweet Potato Beetle.

(*Cassida bivittata* Say.*)

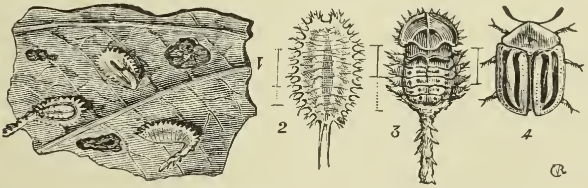

Figure 33.—The Two-Striped Sweet Potato Beetle (*Cassida bivittata* Say). 1, larvae on leaf; 2, larva; 3, pupa; 4, beetle. (After Riley).

Usually this species is recorded as the most common of the Tortoise beetles, attacking sweet potatoes, but this year it has been the least common upon the vines of the Experiment Station. The species differs from the others in several important characteristics, notably in that the larva does not use its faeci-fork for carrying excrement, but merely covers it with cast skins and holds it at an angle from the body, instead of close down upon the back. Dr. Riley states that the species is confined to the sweet potato plant, but we have found it feeding upon morning glory vines early in the season, as do the other species. The larva is yellowish-white, with a longitudinal band along the back, each side of which is a much lighter hand. The beetle is palr yellow, striped with black, as shown in figures 33, 34.

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*(Syn.—Cassida bivattata Say., C. vittula Boheman, C. striolata Boheman.

The Black-Legged Tortoise Beetle.

(*Cassida nigripes* Oliv.*)

The larvae of this species do far more injury to the plants than those of any other species (those of *Chelymorpha argus* Licht., are much more voracious, but are comparatively uncommon on sweet potato,) both on account of their larger size and the manner of their attack. The eggs of other species of the genera Cassida and Coptocycla are laid singly, and thus only one or two larvae will be found on a plant, or if more occur, they are scattered, but the eggs of this species are laid upon the stems in rows of from three to a dozen, and upon hatching, the larvae make a combined attack upon some one portion of the plant, thus making the injury much more noticeable.

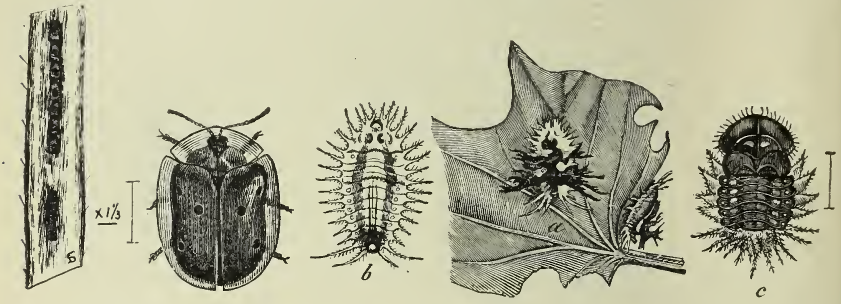

Figure 34.—The Black-legged Tortoise Beetle. (*Cassida nigripes Olir.*) a, b, larvae c, pupa, d, beetle, (After Riley.) e, eggs.

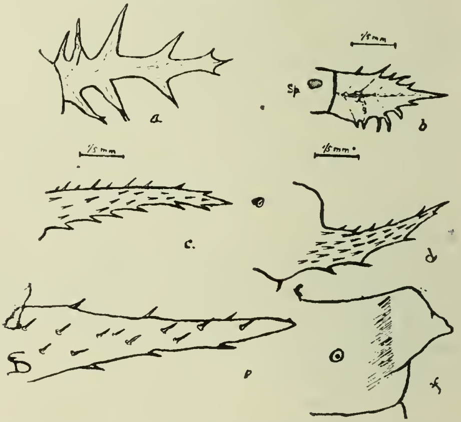

Figure 35,—Lateral tubercles of Cassida larvae and pupae. (*Coptocycla signifera Herbst* a, larva, b, pupa. *Chelymorpha argus Licht*, c, larvae, d, pupa. *Physonota unipunctata*, e, larva, f, pupa. Original.

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*(Syn.—Cassida nigripes Oliv., C. novemmaculata Mann., Var C. nigripes atripes Lec., C. ingripes ellipsis Lec.)

The larvae are a bright, straw yellow, with two crescent-shaped, black marks just back of the head and with the spines at the side of the body tipped with black. They are considerably larger than the other species of Cassida and Coptocycla, and can be recognized at a glance by the characteristic manner in which the dung is spread upon the faeci-fork.

The beetle very closely resembles *Coptocycla bicolor* Fab., but is not so brilliant, larger, has black legs, and the three black spots on each wing cover are larger and more conspicuous.

Cassida Nigripes and the species just mentioned were the most common noticed here this season, and the larvae of the former were the latest in their transformation.

The Golden Tortoise Beetle.

(*Coptocycla bicolor* Fab.)*

This is also a very common species, and may be found upon morning glory vines throughout the summer. The eggs of this species are quite different from other species of Coptocycla and Cassida in having three spiny prongs projecting from one margin. The larvae is easily distinguished by being entirely concealed by the heavy load of excrement which when the faeci-fork is raised and the light color then extends over the less tri-lobed in outline.

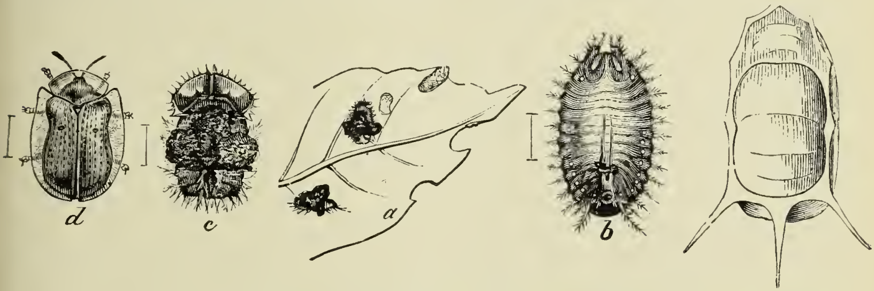

Figure 36.—The Golden Tortoise Beetle (*Coptocycla bicolor Fab.* egg at left, enlarged: a b, larvae; c, pupa: d, beetle. (After Riley.)

Though usually of a dark, brown color with a pale shade upon the back, like the beetle, this larva possesses the power of changing color entire dorsal portion. The pupa with the loaded fork still held close to the back, is hardly distinguished from the larvae at first glance, but when the faeci-fork is raised and the light color then extends over the the fork is removed it may be distinguished from other allied pupae by the three dark stripes on the prothorax and similar dark markings over the abdomen.

The beetles when first emerged, are of a dull, orange color, with three prominent black dots upon each wing cover, but a little later they change to a metallic gold, shining like the most brilliant tinsel, and the black spots are scarcely noticeable. All of the Tortoise beetles, and this in particular, have the habit of dropping to the ground and feigning death as soon as disturbed.

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*(Syn.—Coptocycla bicolor Fabricius, Cassida bistripunctata Herbst., C. aurichalcia Fab., C. aurisplendens Mann.)

The Mottled Tortoise Beetle.

(*Coptocycla signifera* Herbst.)*

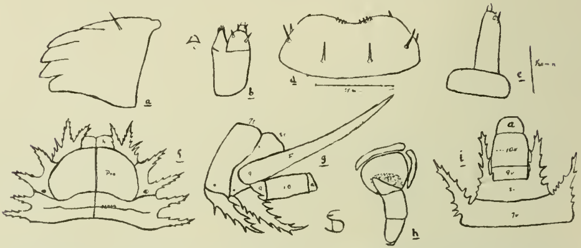

Figure 37.—Larva of *Coptocycla bicolor Fab.* a, mandible, b, maxilla, c, labial palpus d, labrum; e, antenna; f, pro- and mesa--thorax; g, lateral aspect of caudal segments; h, leg, i, ventral aspect of caudal segments.—Original.

This beetle is strikingly different from the other species in being black, marked with six irregular, golden spots, and with a band of black extending across the shoulders to the edge of the transparent margin of the wing covers.

The larva is of a pale straw yellow color during the first four stages, and then carries the excrement upon its faeci-fork in a peculiar branching arrangement much like *Cassida Nigripes* Oliv., but after the last molt the color changes to a pea green, which renders the larva very difficult to recognize upon a green leaf when all excrement is removed from the faeci-fork. Inasmuch as the larva does not feed, and remains almost entirely motionless during the last or fifth stage, this protective covering is a very interesting device or circumstance, which ever way we choose to regard it. The pupa is also of a bright green, marked only by a black ring around each of the first pair of abdominal spiracles.

The Argus Tortoise Beetle.

(*Chelymorpha argus* Licht.)*

The largest of the Tortoise beetles attacking the sweet potato is *Chelymorpha argus* Licht. The common food plants of this insect are milk weeds, but it is also found injurious to raspberry and horse radish, and E. A. Schwarz informs me that a species of Convolvulus is also the original food plant of this species. The beetles vary in size and marking, even from one lot of eggs they are as variable as from different broods.

Thus from eggs which hatched June 19th, 1898 and pupated July 3rd 1898, on July 9th three beetles emerged which were ⅜ of an inch long with a transverse row of four black dots on the prothorax, and the merest trace of two in the caudal angle of the prothorax, the general color being dark yellow. On July 13th, three more beetles of this brood emerged, which were only 9-32 of an inch long, had the four black spots on the prothorax, but also behind them in the caudal angle of the prothorax, two much larger and more prominent black marks, as well as being of a much lighter color. A similar and more striking dimorphism is found in Physonota unipunctata Say., which was formerly the cause of much confusion.

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*(Syn.—Cassida signifera Herbst. C. marylandica Herbst., C. aurata Melsheimer Catalog. 1806, C. guttata Oliv., C. lucidula Boh.. C trabeata Boh.)

*(Syn.—Chelymorpha argus Licht. The synonomy of this species seems to be rather obscure. Gemminger and Herrold give C. cribraria Oliv, as a synonym, though described by him from Guyane. C. cribraria Fabricius seems to have been from "Brasilla." C 17--punctata Say is a synonym.)

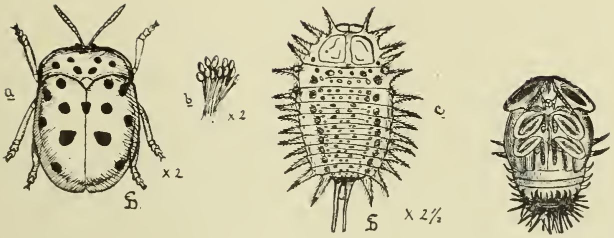

Figure 38.—The Argus Tortoise Beetle (*Chelymorpha argus Licht.*) a, beetle; b, eggs; c, larva.—Original. Pupa, (after Riley) at right.

When fully hardened, the beetle is usually of a brick red color, with six black dots on the prothorax and six on each wing cover, and almost entirely lacking the expansion of the margins of the wing covers and prothorax found in Cassida and Coptocycla.

The eggs are laid in a peculiar manner, being placed in a bunch, each supported by a long stalk or pedicel (Fig. 38, b). Thus when the larvae hatch, they huddle together on the leaves, and very rapidly defoliate a plant. When full grown, the larvae are about one-half of an inch long with the faeci-fork half as long again. They are slightly convex above and stand with the caudal segments elevated: are of a dirty, yellowish color, marked with numerous, dark brown tubercles and prominent lateral spines, as shown in Fig. 38, c. As a rule the faeci-fork is held slanting back from the body and rarely vertical or over it.

The pupa is of a yellowish color, marked with dark brown, which becomes almost black. The ground color of the pupa is almost concealed by a bluish bloom or waxy excretion resembling a mold.

Fortunately, this species is not so common as the others previously mentioned, upon sweet potato, but is often quite injurious to raspberry and horse radish.

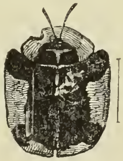

Figure 39 —*Coptocycla clavata Fab.*—After Riley.

In addition to these more common species, are *Coptocycla clavata* Fab., of which the larva is unknown, and which also feeds on the foliage of the Irish potato, and *Cassida nebulosa* Linn, which has recently been found in Lower California, and which has long been known as one of the most injurious of European Cassidae.

From the similarity of their habits and life history, all of these species are readily treated at the same time. Inasmuch as the beetles do the most injury as soon as the plants are set, a dipping of the plants in a solution of the arsenate of lead, as advised for the flea beetles, is doubtless the easiest and most effective means for their destruction. Otherwise, a spray of Paris green should be used as soon as the plants have been set, at the rate of one-quarter pound of the poison, and one-quarter pound of lime to 40 gallons of water. This may best be applied by means of a knapsack sprayer, and the use of an under spray nozzle, so that the under sides of the leaves may be thoroughly sprayed. In either case the object should be to have the plant so coated with poison that the first meal of the beetles will mean their death, thus killing them before they can do serious injury or lay their eggs.

Remedies.

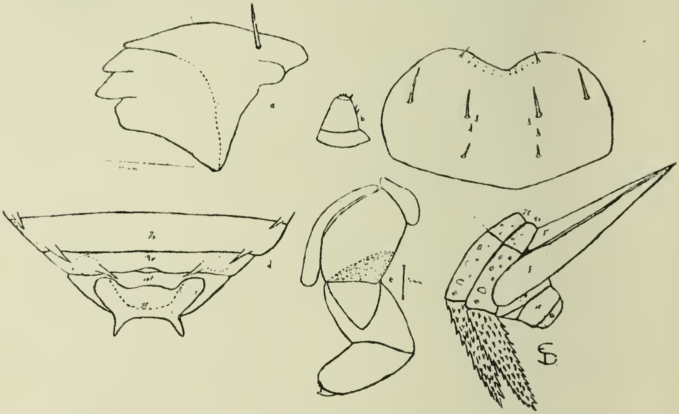

Figure 40.—*Chelymorpha argus Licht* **larva. a, mandible; b, antenna; c, labrum; d, ventral aspect of candal segments of pupa; e, leg; f, lateral aspect, candal segments of larva. —Original.**

Sawflies.

(*Schizocerus ebenus* Norton.)

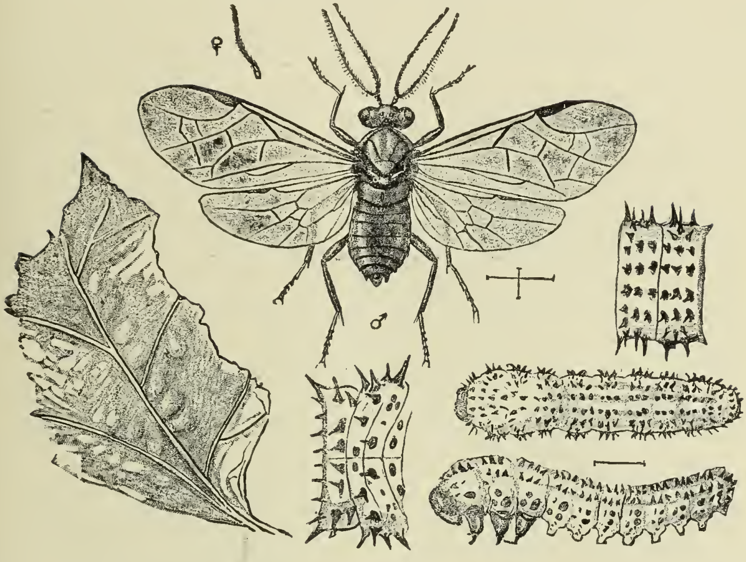

Figure 41.—*Schizocerus ebenus Norton*. Adult Saw-fly above, larvae at lower right (After Riley.)

In 1886, Dr. C. V. Riley, then U. S. Entomologist, described (Insect Life, Vol. 1, p. 43), the injuries and various stages of a sawfly, the larvae of which had practically ruined a crop of sweet potatoes at Ocean Springs, Mississippi. The pest was somewhat injurious for the next two years, but since then, has not been noticed as especially injurious, though the adult insects have been noticed in sweet potato and morning glory

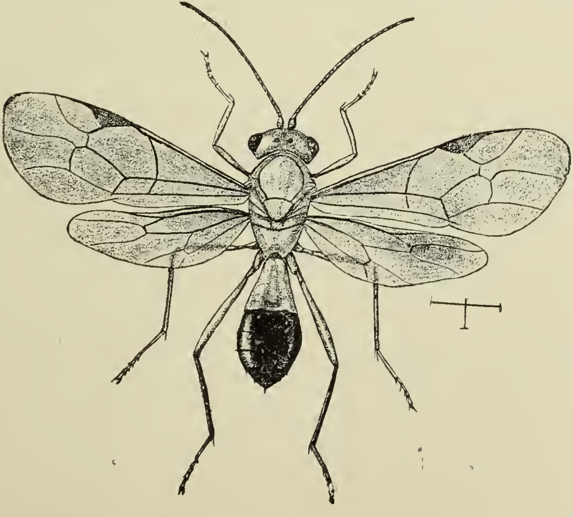

Figure 42.—*Enbadizon schizoceri*, enlarged. (After Riley.)

vines in Nebraska. Doubtless, this may be largely due to a little hymenopterous parasite, which Dr. Riley bred from one of the specimens sent him (Fig. 42), and also a small parasitic Tachinid fly. The maggots of these flies live internally upon the juices and tissues of the sawfly larva, and thus probably keep their numbers so largely reduced that their injuries are not ordinarily noticed.

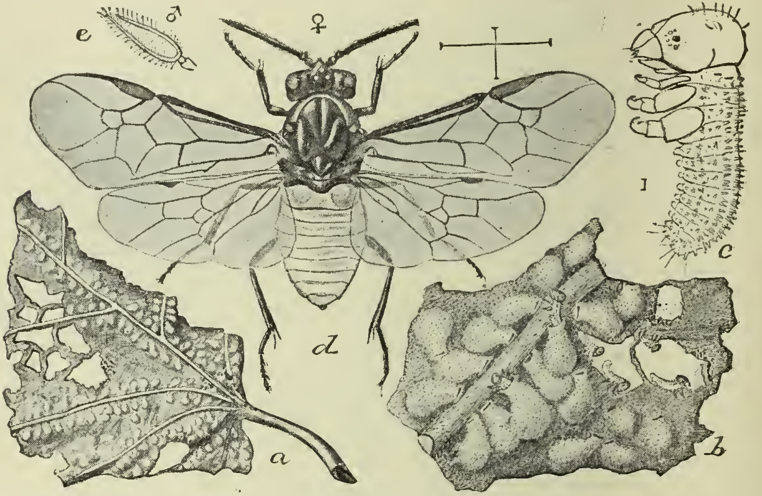

Figure 43.—*Schizocerus privatus Norton.*—After Marlatt.

(*Schizocerus privatus* Norton.)

The larvae of another insect of the same genus was recorded by Mr. C. L. Marlatt, in 1891, (Insect Life, Vol. 5, p. 924,) as being reported as seriously injurying the crop of Mr. C. W. Stockley, Keller, Accomac county, Virginia. I have been unable to learn of any depredations by this insect in Maryland. It seems entirely probable, that, being prevented by further spread southward by the channel of the Chesapeake Bay, it should cross the line and spread into Worcester and Somerset counties, Maryland.

Concerning the work of these larvae, Mr. Stockley then wrote: "Last year, (1890,) was the first time they made their appearance in my potato patch. They came the first of July and deposited their eggs on the leaves; when the eggs hatched, these worms would eat the leaves to a comb. This continued for about four weeks. The potatoes, wherever the fly was, did not make any yield at all. This year the fly made its appearance at the same time they did last year."

Mr. Marlatt found that this species also had a small tachinid fly parasitic upon it.

Adult flies are recorded from Michigan and Nebraska, and were originally described from New Orleans, La.

Remedies.

A spray of Paris green, used as devised for the Tortoise beetles, will be found effective for destroying these worms and should be applied as soon as their injury is noticed, preferably when just hatching from the eggs.

The Sweet Potato Plume Moth.

(*Pterophorus monodactylus* Linn.*)

While examining the vines of the Experiment Station on June 15, I found several small, green worms eating the foliage, and subsequently almost every plant brought into the laboratory was found to have from one to three of them upon it. At that time most of the larvae were half grown, though many were but newly hatched, and one was found already pupated. When full grown the larvae are about one-half an inch long, of a bright green color, with a darker stripe along the center of the back, and thickly studded over the entire body with prominent tubercles, from each of which project a number of stiff, bristly hairs. The prolegs are prominent and have a peculiar, elongated development.*

The larva pupates upon the under sides of the leaves, where the pupa remains suspended by the caudal portion. The pupae are about the same size as the larvae of a bright silvery-brown color, with the spiracles, eyes, a large shield-shaped mark on the dorsal side of the first and second abdominal segments, and small dots similarly placed upon the other abdominal segments and thorax, of a dark brown.

On July 26th, a small moth emerged, and two emerged each day on July 28th, 29th and 30th. These moths were kindly determined for me by Dr. C. H. Fernald as Pterophorus monodactylus Linn., who writes that he has not known of it as having been injurious to sweet potatoes. The growth of the plant is so rapid that the larva is soon left below among the larger leaves. The larva then, in most cases, eats half way through the petiole of a large leaf; the leaf soon wilts and the larva finds shelter beneath the wilted portion. The moths have also been collected in Colorado (Edwards), Salem, Mass. (Putnam), California and Oregon (Walsingham), Texas and Ohio (Zeller),) Illinois and Europe (Dimmock).

The moths are very pretty, silvery-brown insects. The fore-wings are streaked with black and expand about seven-eights of an inch. They belong to the family *Pterophoridae*, commonly known as "Plume Moths," from the fact that instead of having two wings, as do most moths, they seem to have five. I say "seem to have," for they really have but two, the fore-wings being split through the center and the hind wings divided into three parts. Each part of the wing has a broad fringe of hairs on both anterior and posterior margins giving it a feather-like appearance. In repose, the wings are folded together and extended at right angles to the body. When so resting motionless upon a leaf with their long, slender legs held close to the body, they appear exactly like a small, dead twig or piece of grass, and are readily overlooked, the writer having even overlooked them when searching for them in a breeding cage.

Dr. Asa Fitch, New York State Entomologist, was the first American writer to notice this insect (1st. Report 1856, Pg. 144), and in 1856 recorded it as being "taken the forepart of July in yards around dwellings." The moth was described by him as P. cineridactylus, which Lord Walshingham (Pterophoridae of Cal. & Ore. 1880 pl. II, Fig 16, pl. III, Fig. 1), has since determined to be a synonym of P. monodactylus Linn., as is also P. pergracilidactylus Pack. (Ann. Lyc. Nat. Hist. N. Y. 1873, Vol. 10 Pg. 265.) Mr. Geo. Dimmock, who is a student of this family, records it (Psyche Vol. III, 404,

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*(Syn.—Pterophorus monodactylus Linn.—P. Cineridactylus Fitch.,—P. pergracilidactylus Pack.

*I regret that I was unable to make a more detailed description of the live larvae, and now have only alcoholic material.

1882) as very injurious to the plants nearly related to the sweet potato, Convolvulus tricolor and Ipomea purpurea in Cambridge, Mass. Of its habits upon these plants he says: "The larva usually eats into the leaf and flower buds of C. tricolor; on I. purpurea it begins."

Insects of Minor Importance.

Previously Recorded as Injurying Sweet Potato Foliage.

In 1887, Dr. Riley recorded (Insect Life, Vol. 1, p. 987,) a true cricket of the genus Gryllus as being sent him from Catatioula Parish, La., as doing injury to the sweet potato. In reply to inquiry, Mr. Micheal Dempsey, of Jena, wrote him under date of May 7th:—"They infest portions of the hills and swamp lands alike, sweet and Irish potatoes, peas, and tobacco. Our farmers are seriously alarmed at their fearful increase and their destructive habits. Their holes in the ground are promiscuously scattered from a few inches to several feet apart, and are seldom over a foot deep in uplands, although they go much deeper in swamp lands, as the soil is deeper, and the sub-soil softer. They are seldom visible in the heat of the day, and do their cutting at night, taking all they want down into the ground, where they eat as they please. In 1852, I first noticed them eating cotton only, and a few years back they began to eat sweet potatoes. Now they eat peas and tobacco and have attacked our gardens. We find that rapid cultivation, large gangs of poultry and numerous birds keep them in check, but they are becoming too numerous, in spite of all we can do."

Dr. Riley advises a bran mash, such as we have already described for cut worms, and doubtless this would be entirely efficient, as it has often been successfully used in California against grasshoppers.

In his second report of the injurious insects of Missouri, Dr. Riley has also recorded the cucumber Flea Beetle (*Epitrix cucumeris* Harr,) so injurious to the Irish potato, as injurying sweet potatoes. The treatment already recommended for the Sweet-potato Flea Beetle would apply equally well to this species.

The larvae of one of the Spingidae somewhat similar in appearance and habit to the tobacco worm (*Phlegethontius carolina*,) sometimes do serious damage to the foliage. The moth (*Macrosila cingulata*) has therefore been termed the Sweet Potato Hawk Moth. As the caterpillars are large and the injury done by them is very apparent, hand-picking has proved to be the best remedy, though also destroyed by Paris green.

PUBLICATION

OF THE

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Some Diseases of the Sweet Potato and How to Treat Them.

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OF THE
MARYLAND AGRICULTURAL
EXPERIMENT STATION,
COLLEGE PARK, MD.
MARCH, 1899.

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THE MARYLAND

AGRICULTURAL EXPERIMENT STATION

BULLETIN No. 60. MARCH, 1899.

Some Diseases of the Sweet Potato and How to Treat Them.

By C. O. Townsend, M. S., Ph. D.

INTRODUCTORY.

The sweet potato is one of the most important crops in certain sections of the State, and since it is subject to numerous fungous diseases, which destroy annually thousands of barrels of these tubers, it has been deemed advisable to present a brief account of some of the more important of these diseases, and to consider some means of controlling them. All the diseases referred to in this bulletin are produced by minute organisms called fungi. These organisms are small plants which are unable (owing to the absence of green coloring matter in their cells) to prepare their own food material, and which must, therefore, depend for their nourishment directly or indirectly upon green plants. If fungi derive their sustenance directly from other living organisms, they are known as parasites, and the plant (or animal) upon which the parasite grows, is known as the host. The parasitic fungus may produce disease in its host in several ways; viz. it may rob its host of a portion of the nourishment that the host has prepared for itself; it may feed upon the living substance of the host; or it may in the process of growth produce a substance which acts as a poison upon the host, thus destroying its life. It is not to be understood from what has been stated that all parasitic fungi produce disease; indeed, some are beneficial to their hosts. Some disease-producing fungi always choose the same plant species for their host, others are able to live just as well upon related species, others flourish upon host plants not at all related, while still others thrive equally well upon either living or dead organic matter. Another important fact in regard to fungi is that they are sometimes able to live equally well upon all parts of the plant, whether above or below the surface of the ground. Keeping in mind these facts in regard to parasitic fungi and their hosts, it will not be difficult to understand the nature of sweet potato diseases and the best means of controlling them. Several cuts have been introduced to aid in understanding the nature and appearance of these diseases, which, since they are produced by different fungi, will be considered separately.

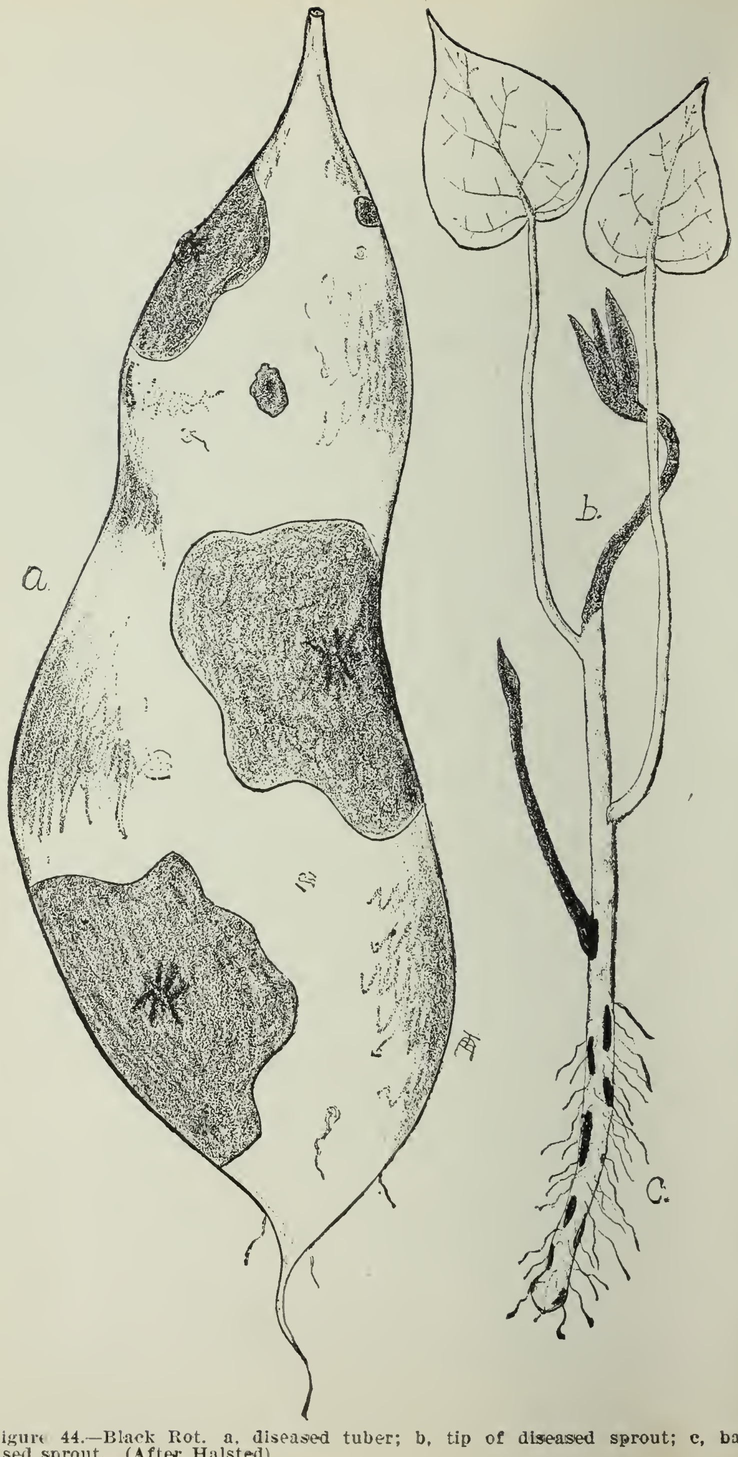

Figure 44.—Black Rot. a, diseased tuber; b, tip of diseased sprout; c, base of diseased sprout. (After Halsted).

Black Rot.

Appearance of Disease.

This disease has been known for many years, but has apparently become more destructive of late, until it is the most troublesome disease of the sweet potato in this State. It is liable to attack the plant at any time during its existance; and even after the crop has been gathered, it often continues its destructive work, doing a vast amount of damage to the stored tubers. Fig. 44, a, shows a tuber that has been attacked by black rot in several places, as shown by the dark patches. The point of attack is at first very minute, and may easily be passed over unnoticed; this is often the case when the potatoes are gathered, but as time goes on the spots increase in size and depth until the whole tuber is destroyed. Fig. 44 b represents the young shoot of sweet potato that has become very seriously affected with the disease. The upper part of the plant has been killed and the lower part, c, is seriously affected, hence we have in this instance a disease capable of affecting any part of the plant.

In Fig. 49, a and b we have another appearance of the black rot in which the root turns perfectly black, as shown by the cross sections in the figure due to the presence of nodules, c, which fill the tissues of the diseased tuber.

Black Rot Fungus. (Ceratocystis fimbriata, Ell. and Hals.)

In order to understand more fully the nature of the disease and the manner in which the attack is made, it will be necessary to examine the following cuts. Fig. 45, a shows a portion of a fungus with branches, upon the end of which two kinds of spores are borne. The end cells of the tapering branches like b fall away and form independent bodies (spores) from which new fungi are formed. Fig. 45, b shows such spores enlarged, one of which has begun to grow. Other branches as at c in the same figure, enlarge at the ends and form a second kind of spore. These spores are much thicker walled than in the preceding case, and in consequence much more resistant, i. e. they do not germinate as readily as the spores b. Spores like those represented at d often spread the disease at once, while those represented by e usually remain in the resting condition for a longer or shorter time, depending upon external conditions. As the spots shown in Fig. 44 a increase in size, and consequently in age, they gradually change their appearance, finally showing a broken spot near the center, which is darker than the rest of the area. If a portion of one of these dark centers be magnified, it will be found to contain a number of flask-shaped bodies with long necks, as shown in Fig. 46. Within the enlarged part of each flask numerous spores different from either of the other kinds are found. When these spores are ripe, they pass up through the long neck of the flask and escape at the free end. They are often held in a mass by means of a gelatinous substance, which escapes with the spores, as shown in Fig. 46, a. These spore masses will dissolve if they are moistened and the spores will float away in the liquid, often finding suitable lodging place for development. Fig. 47, a shows one of the flask-shaped bodies removed from the tissue of the potato and much enlarged; b shows the free end of the neck still more enlarged, spores that were formed in the flask are escaping, and spores of the

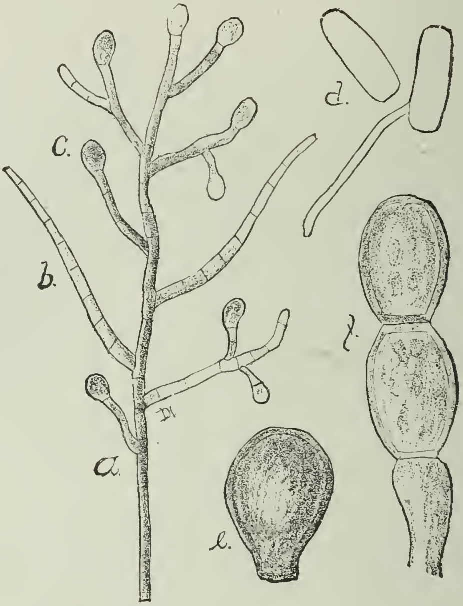

Figure 45.—Black Rot Fungus. a, branching filament; b, branch producing thin-walled spores; c, more resistant spores; d, spores from branch; b, enlarged and free; e, spore c enlarged; f, intermediate form of spore between b and c. (After Halsted).

second class are forming on the surface; c represents some spores of the third class formed and others in the process of formation. Spores of the first and second classes form on the surface of the enlarged part

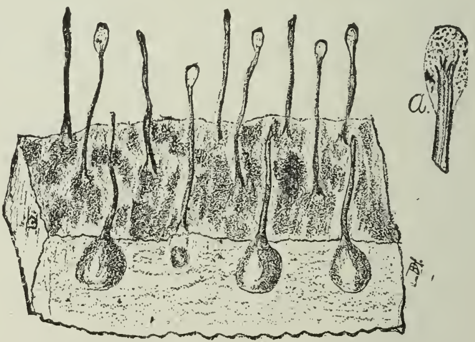

Fig. 46.—Black Rot tissue showing spore conceptacles a, tip of neck more enlarged, showing spores in gelatinous mass. (After Halsted).

of the flask as well as upon the elongated neck. (See Fig. 48.) It would be very easy to mistake these fungous structures and their spores for different fungi, if patient investigation had not shown that they are all the same, only the flask is composed of fibers, so arranged and so compact that a flask-shaped body is formed within which spores are produced. The method by which the spores are formed is shown in Fig. 46, c. The threads of the fungus enlarge and turn dark in certain places forming nodules as shown in Fig. 49, c.

Fig. 50 shows the various stages in the development of these nodules; a represents a fungous thread that has slightly enlarged and divided into a few cells; b, c, d, and e shows the succeeding steps in the process, e being the complete nodule.

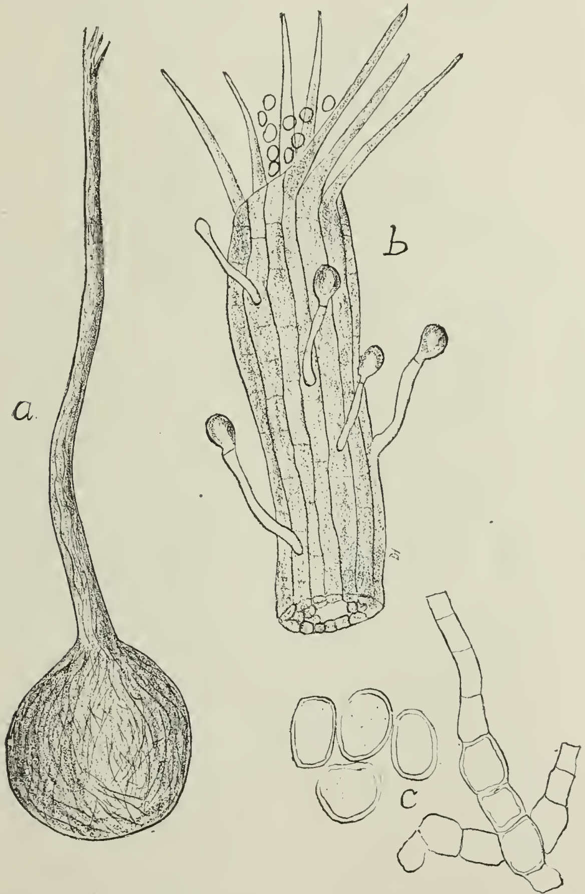

Figure 47.—Black Rot. a, one of the flask-shaped bodies removed from the potato and magnified; b. tip of same still more enlarged, spores escaping; c, spores forming. (After Halsted).

This seems to be a provision of nature by which the fungus is enabled to live over those seasons that are unfavorable for immediate development, since the nodules often retain their vitality until the conditions are suitable for growth. Although these bodies are not strictly spores, they perform the same functions as spores, inasmuch as they are the starting points of new fungi when the conditions for growth are suitable. Upon the surface of these nodules it is not uncommon to find spores of the second class developed as shown in Fig. 51, a.

We see from the preceding cuts and from what has been said in regard to them, that nature has taken many precautions to prevent the extermination of the fungus. Not only is this evident from the great variety of spores produced, but also from the fact that many of the spores or spore bodies are capable of retaining their vitality for an indefinite period. Hence the soil in which potatoes affected with black rot have been grown must become charged, especially with the spores that are formed in connection with the underground part. It is an important fact that only the first and second kinds of spores are formed during the early stages of this disease.

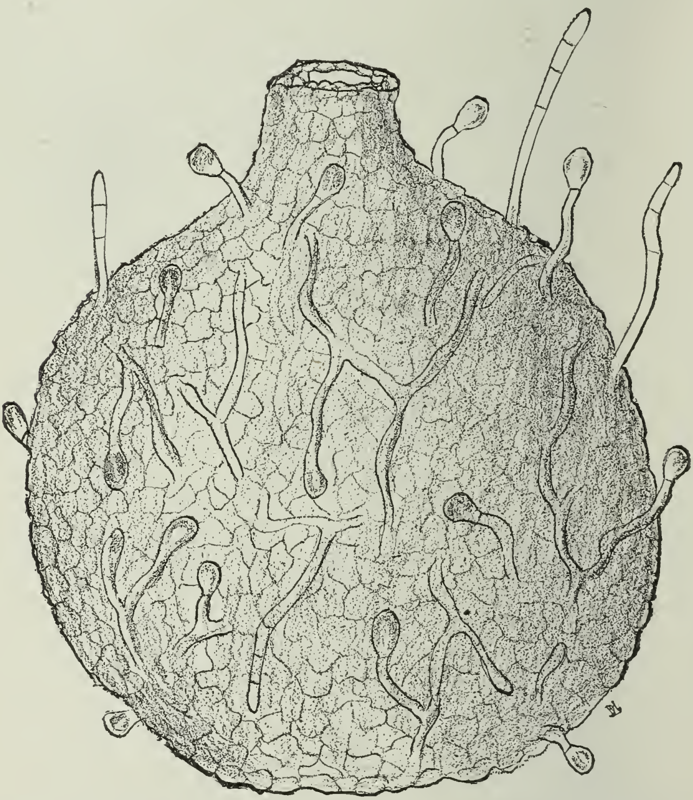

Figure 48.—Black Rot. Base of spore cavity, much enlarged and showing spores upon the surface. (After Halsted).

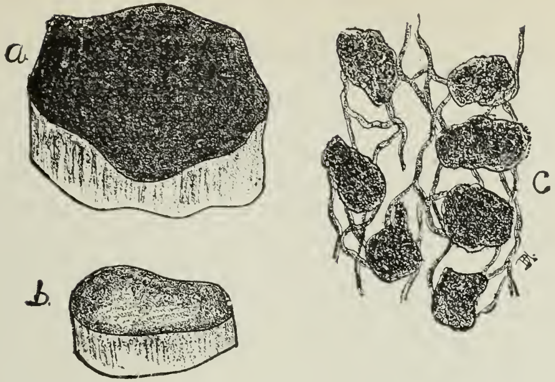

Figure 49.—Black Rot. a, portion of potato; b, same younger; c, portion of a, magnified. (After Halsted).

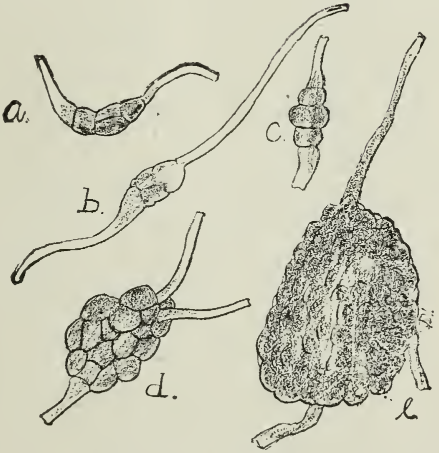

Figure 50.—Black Rot. Development of nodules. (After Halsted).

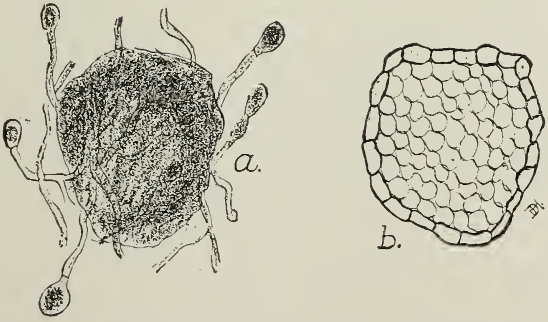

Figure 51.—Black Rot Nodule. a, with spores upon the surface; b, same in cross section. (After Halsted).

Remedy.

Owing to the nature of this disease, as already explained, it is important that every precaution be used to prevent it from getting a foothold. To this end, care should be taken that no diseased tubers be used for producing sets. Young plants should be selected with the greatest precaution, and all diseased or suspicious plants should be discarded. Attention should also be paid to the general vigor of the plant, since a sickly plant is more liable to attack than one that is strong and capable of vigorous growth. If there are no germs of disease in the soil, and the sets are not infected at the beginning, it is not probable that the plants will be attacked by this fungus, but if an attack is feared, the young plants should be sprayed with Bordeaux mixture, which will prevent the development of spores that may be brought into contact with them by the wind or other agencies. Care should also be taken that disease spores are not spread upon the land in manure. As a precaution against this common method of spreading disease, all diseased plants or plant parts should be burned. If, in spite of all precautions, the tubers become affected with the black rot, so that the soil becomes charged with the spores, it will be necessary to rotate the crops, planting no sweet potatoes upon that land for several years, until the fungus is starved out. It often happens that the tubers are so slightly affected with this disease that it is not noticed at the time the potatoes are gathered. In this case the tubers will continue decaying in the bin until they are unfit for use. To prevent this loss, the potatoes may be soaked for a short time in Ammoniacal carbonate of copper, but it is better to examine them carefully before storing, and throw out any that show diseased spots.

Soil Rot.

Appearance of Disease.

This disease is confined to the underground portions of the sweet potato, causing the part attacked to cease growing, a condition which renders the tubers very unshapely, since the parts adjacent to the point of attack continue to grow, as shown in Fig. 52. These roots may be affected at any time during their growth, but the effect upon the development of the tuber is greater if they are attacked while still small, since they are thereby rendered more unshapely and less salable. Fig. 52, a shows a tuber that has been attacked at three points, c, another that was attacked at two points when the tuber was small, thus dividing it into three parts. The point of attack is at the base of a rootlet, as shown in d, where two spots have just begun to form. Only the spots attacked are rendered unfit for use, the adjacent parts remaining still edible and retaining their usual flavor. The attack is usually confined to the surface, and as the diseased part becomes older it often cracks and falls away, the growth of the fungus at that point ceasing.

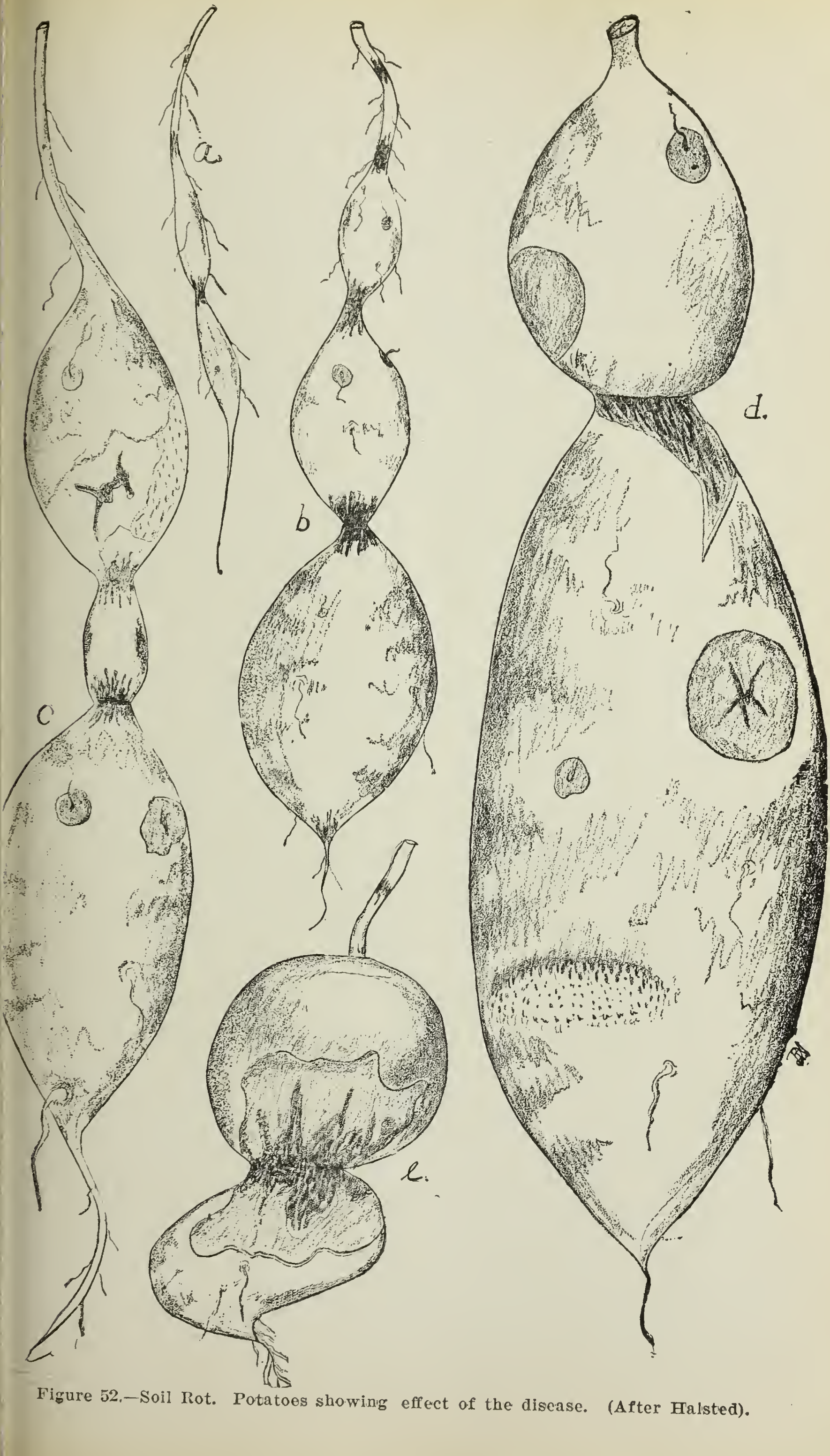

Figure 52.—Soil Rot. Potatoes showing effect of the disease. (After Halsted).

Soil Rot Fungus: (Acrocystis batatas. Ell. and Hals.)

As in the preceding case of Black Rot, soil rot is produced by a distinct fungus, although the two fungi are very different in their habits and in their method of spore formation. The vegetative part consists of elongated, much branched filaments, which extend into the tissues between the cells, thus causing the decay of the tuber at that point, and a consequent cessation of growth. The spores of the fungus are formed in the filaments, as shown at a and b Fig. 53; the filaments become slightly enlarged when the spores are formed; the spores may be few, as in a, or numerous as in b. Sometimes the ends of the filament enlarge and become filled with spores, as in c. When the spores are ripe, the walls of the filament or of the sacs break or dissolve, and the spores escape; d shows one of the sacs collapsed, only a few spores remaining within. The walls of the spores are thicker than the walls of the filament, as shown in Fig. 53, e. This protects the contents of the spores from external conditions, and enables them to remain alive for a long time, when the conditions are not favorable for their germination and development. When the spores are ripe they turn dark, giving a brownish color to the diseased portion of the potato. As soon as the conditions for growth are favorable, the spores germinate and send their thread-like structures into the tissues of the potato, from which they draw their nourishment and soon produce new spores.

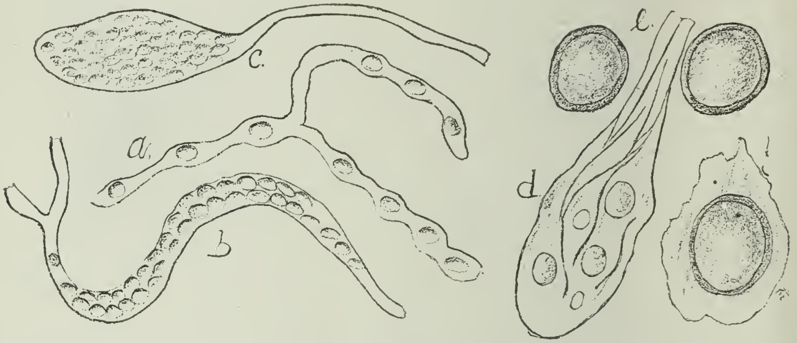

Figure 53.—Soil Rot Fungus. a and b, filaments with spores; c, swollen tip with spores; d, collapsed tip; e, enlarged spore.(after Halsted).

Remedy.

Knowing that the spores of the fungus that produces the disease are formed in or on the tubers, it is apparent that the process of spraying the top would be of no avail in preventing or in curing this disease. Since the disease arises from the spores that are in the soil, it is evident that the trouble may be averted either by so treating the young plants that the fungus is not able to attack them, or by destroying the spores before they are able to produce fungi. Numerous experiments have been performed in accordance with the first method, but with little or no success. Several methods have been employed to destroy the spores in the soil, one of which is the same as that employed for black rot, viz. the rotation of crops. If this method is employed, it is necessary to grow other crops than sweet potatoes upon the soil for a number of years after the soil rot makes its appearance. While this method would undoubtedly be successful if carried far enough, it is not always practicable, since a field that is particularly well adapted to the growth of sweet potatoes cannot well be given up to other crops for a long term of years. In the last few years numerous experiments have been carried on in New Jersey under the direction of Prof. Halsted for the purpose of finding some method by which this disease may be controlled. Though the kindness of Prof. Halsted the results of these experiments have been placed at the disposal of the writer. Six substances were tested, viz: lime, sulfur, manure, corrosive sublimate, kainit and copper sulfate. These substances were applied alone in different quantities and also in combinations of two,

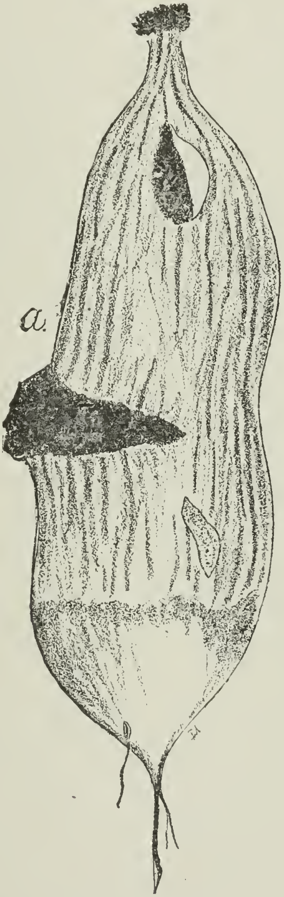

Figure 54.—Soft Rot. Tuber one-half natural size. (After Halsted).

with the result that while kainit alone has the power to hold the disease in check, sulfur is much more effective. Indeed, when the latter substance was used a crop resulted nearly three times as great as that in the control experiments, in which no remedy was employed, and less than one-third of the tubers produced were marked with the disease, even though the soil was filled with the spores which produce the soil rot fungus. It has been observed that the best results have been obtained when the two substances, sulfur and kainit, are sown broadcast, and thoroughly mixed in the soil where the new roots are to form. In regard to the quantity to be used, Prof. Halsted says that three or four hundred pounds each of sulfur and kainit may be used. While this treatment does not seem to prevent the disease entirely, it tends to reduce it to a minimum, and to give such results in the yield of sound tubers as to warrant its use. While the fungus is the direct cause of this rot, the extent of the damage depends largely upon the weather. The greatest amount of damage is usually done early in the season, and there is nothing to be feared from the disease after the tubers are stored.

Soft Rot.

Appearance of Disease.

This disease appears most commonly after the tubers have been stored, and does not originate upon the leaves or vines. The attack is usually made near the top of the tuber, where it was broken from the vines, and extends downward, often giving to the tuber a somewhat shrivelled appearance Fig. 54. If the skin is broken, a black mass is soon formed, as seen in Fig. 54, a. If the skin remains intact, there may be no indication that the tuber is diseased, but if it is broken, the black mass soon forms. Another characteristic of this disease is the disagreeable odor which is emitted by the decayed substance.

Soft Rot Fungus: (Rhizopus nigricans, Ehr.)

As in the two preceding cases, the disease is produced by a well defined fungus, the main features of which are shown in Fig. 55. In a is shown a small portion of two fungous threads as they appear in connection with a few of the cells of the potato b. These threads are much branched and thus present considerable surface. The injury to the tuber is produced not so much by the amount of material absorbed by the fungus, as by a substance which it excretes, and which causes the starch in the potato cells to dissolve and the cell walls to decay more or less completely. Fig. 55, c shows a whole fungus, which produces soft rot. The part below g grows into the tissue of the potato, as shown in a and produces the damage, while the upper part is designed for the reproduction of the plant. This upper part grows towards the light, and under proper conditions the stalks enlarge at the ends to form globular sacs, the contents of which break up to form a large mass of spores. If the skin of the potato is not broken it is possible for the fungi to grow all through the tissue of the potato without producing any spores, but if the skin is broken, stalks are soon pushed out upon the ends of which the spore sacs are formed. When ripe, these spore sacs filled with spores are dark colored, and this gives the black appearance to the mass, as shown in Fig. 54, a. One of these spore sacs filled with spores, is shown at d, another one, which is older, and which has broken, allowing nearly all of the spores to escape, is seen at e; while a still older and completely empty one is seen at f. Some of these spores are shown at h, one of which has begun to germinate.

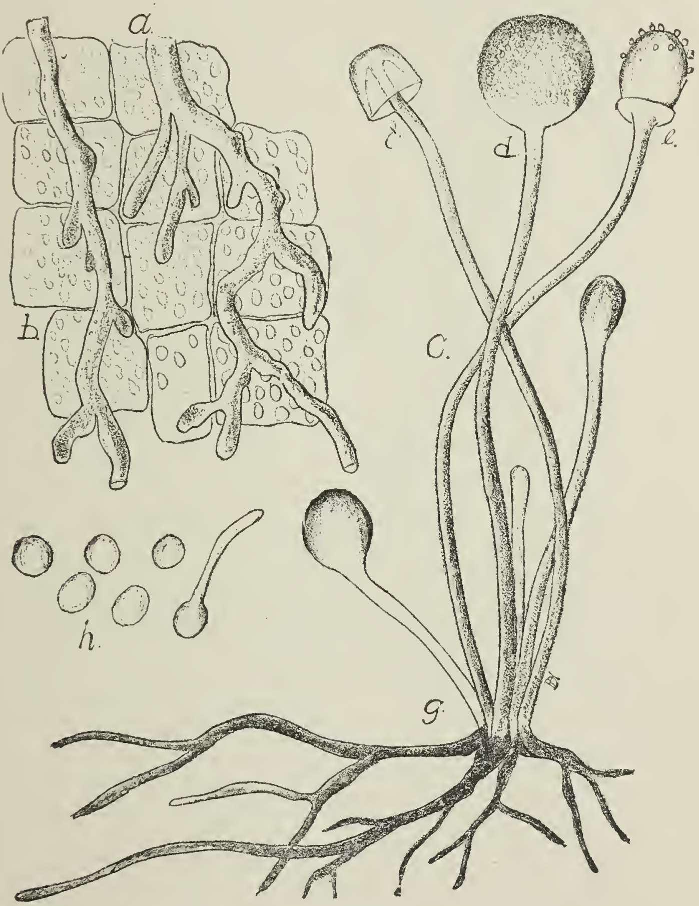

Figure 55.—Soft Rot Fungus. a, fungus threads; b, cells of potato; c, mold fungus much enlarged; d, spore capsule; e, older state; f, collapsed capsule; g, base of mold plant; h, spores. (After Halsted).

All of these figures are, of course, greatly magnified. In order to produce this disease, it is necessary for only a few of these spores to lodge either at the point where the tuber was broken from the vine or upon some point on the tuber where its skin is broken. As soon as the condition of temperature and moisture are suitable, the spores will germinate and the disease is established. The disease itself can be spread from tuber to tuber only by means of the spores, but the juice from a decayed potato may cause another potato with which it comes into contact to rot. This arises from the fact above stated that this fungus produces a substance which causes the decay of the cells of the tubers.

Remedy.

Since this disease rarely occurs until after the tubers are stored, it is useless to spray the plants in any stage of growth for soft rot. There are a number of precautions, however, which, if strictly observed, will retard to a very large degree the ravages of this pest. Great care should be taken against bruising the tubers or breaking their skins while gathering and storing them, since we have learned that it is where the skin is broken that the fungus finds a foothold. It is also important that the tubers should be kept at a proper temperature after storing, i. e. from 70 to 80 degrees. This requires some kind of heating apparatus, which may be kept constantly in operation, and which is easily adjusted. Furthermore, the potatoes should be stored in a dry place, since moisture is an essential condition for the development of the fungus. The Louisiana Experiment Station recommends the use of fostite (a powder composed of copper sulfate and soap stone), which sprinkled over the potatoes in the bin prevents the spread of the rot. Even after all these preventive measures have been employed, the stored tubers should be watched, and those that are diseased should be removed from the bin as soon as they are detected. Especial attention should be given to these precautions during the sweating period after they are stored.

Stem Rot.

Appearance of Disease.

Stem rot makes its appearance in the stem close to the surface of the ground, and extends in both directions. The influence of the rot extends much farther than the fungus which produces it, for example, the vine turns yellow and finally dies as a whole, unless it has produced roots at one or more of its joints, in which case the vine remains green from the rooted joint to the tip. Hence the death of the vine is produced by the decay which takes place near the surface of the ground, since the rest of the vine is thereby cut off from the supply of food and moisture. While the vines are dying from the effects of this fungus, the disease is extending downward into the roots, and causing more or less complete decay of the tubers. This explains the fact that the decay of the tubers begins almost invariably at the top as seen in Fig. 56, in which different stages of the decay are shown. Often the partially decayed tubers send up new shoots, as shown in a and b, Fig. 56.

This second growth of shoots does not succeed in producing new tubers, and, in short, a hill which has suffered from stem rot is practically worthless.

Stem Rot Fungus (Nectria ipomoeae. Ell. and Hals.).

The vegetative part of this fungus spends its existence within the tissue of the host plant. The spores are formed within elongated, sac-like bodies, and these in turn are enclosed in flask-shaped cavities. These cavities form elevations on the surface of the affected parts(which usually appear as flesh-colored clusters). The spores are usually produced in definite numbers within the sac (commonly eight), and each spore is double, i. e. composed of two cells.

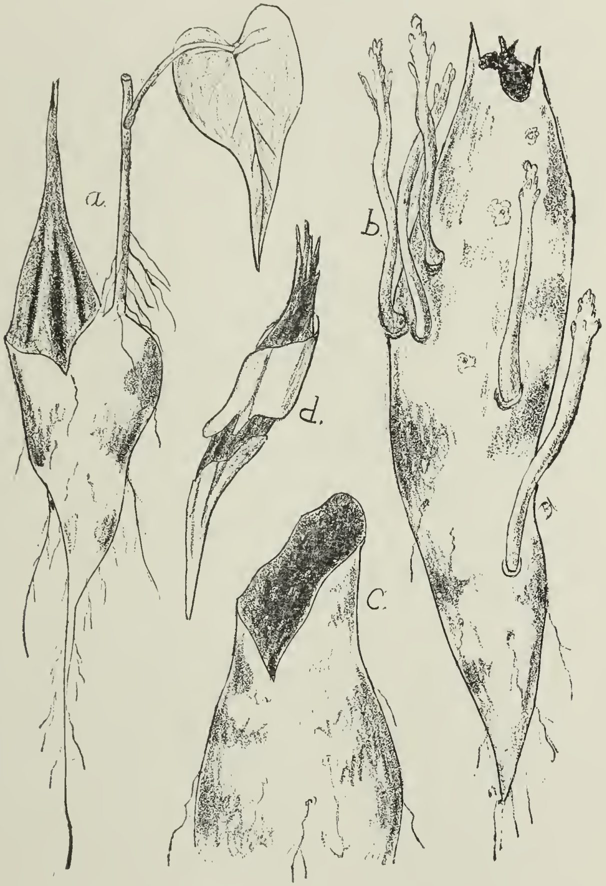

Figure 56.—Stem Rot in its different stages. (After Halsted).

Remedy.

Since this disease is produced by the spores in the soil, the same general treatment mentioned in the preceding cases should be employed, viz. rotation of crops with long intervals between the crops of sweet potatoes; cultivation and fertilization, so that the sweet potato plants may be strong to resist the attack of the fungus. Various treatments of the soil have been suggested. It is certain that if the soil could be sterilized by subjecting it to a high degree of heat, the spores could be destroyed. The only difficulty here is the method by which the proper degree of heat could be applied to a considerable area of ground and for a sufficient length of time to destroy the germs. There is, so far as known, no practical method for destroying these spores, except to starve them out by rotation, as stated above.

White Rot.

Appearance of Disease.

This disease attacks the tubers, causing them to assume a white, dry, chalky appearance. The attack is first noticed in the form of a slight depression at the base of one or more of the hair-like rootlets. These diseased areas enlarge and deepen until possibly the whole potato is of a chalky consistency. The potatoes affected with the disease emit no odor, and if the skin is not broken, they may be entirely overlooked. If we cut through one or more of the depressions mentioned above, we shall find that these spots consist of white, chalky matter, underlaid by a darker tissue, as seen in Fig. 57, a. It is in the tissue underlying the white spots that the fungus lives, which produces this chalky substance and transforms the living tissue of the potato.

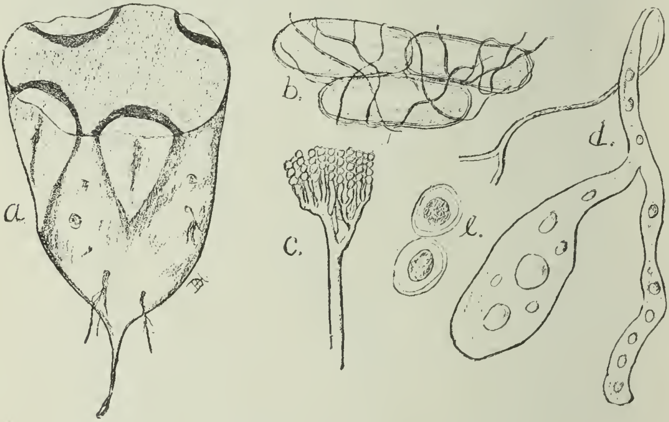

Figure 57.—White Rot. a, portion of diseased potato; b, cells of potato and fungus threads; c, spore formation; d and e, second spore development. (After Halsted.)

White Rot Fungus.

The vegetative part of the fungus is composed of very fine, thread-like tubers, which branch copiously and extend in all directions between the cells of the host plant Fig. 57, b. Under favorable conditions these threads find their way to the surface; send up long, vertical tubes which form a number of branches on the free end, and which in turn produce a chain of spores Fig. 57, c. A second class of spores is formed within the thread-like structures of the fungus. For this purpose the fungus threads may enlarge at any point, but it is more common for them to enlarge at the ends, as shown in Fig. 57, d.

These spores as shown at e are thicker walled, and hence much more resistant toward external conditions than are the spores of the first class. Sometimes this fungus forms moldy spots on the surface of the potato, these patches assuming a bluish color very similar to the molds that grow on bread, preserves, and other organic matter.

Remedy.

Since the spores of this fungus are produced on the tuber, it is not surprising that they should remain in the soil ready to attack the next crop of sweet potatoes. Hence, in order to prevent the ravages of this disease, it is necessary to rotate crops, and thereby to starve out the fungus. Care should also be taken that all of the sets are healthy; thus reducing to a minimum the probability of transmitting the disease to the field along with the sets, and at the same time doing away with the weakest points of attack which are always the sickly plants.

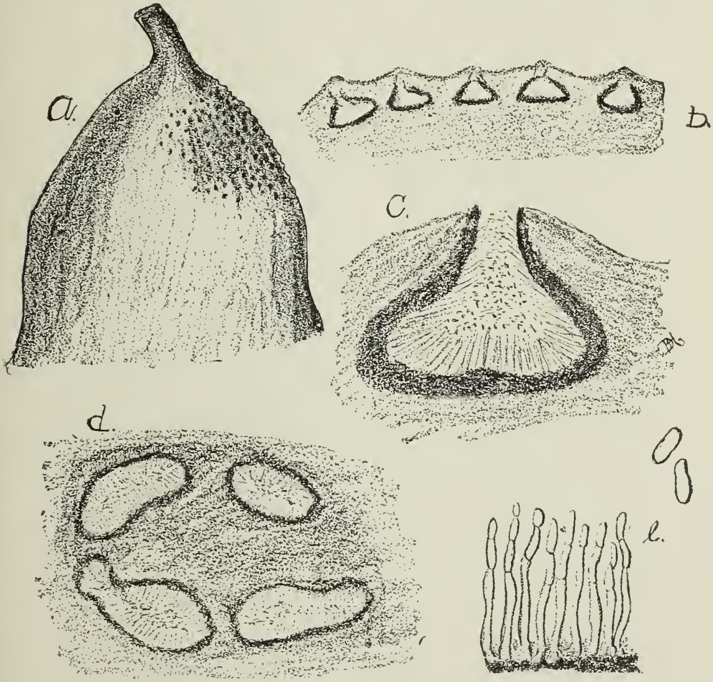

Figure 58.—Dry Rot. a, portion of diseased potato; b, section showing fungus pits; c, same enlarged; d, interior spore formation; e, spores and filaments within the pits. (After Halsted).

Dry Rot.

Appearance of Disease:

This disease attacks only the underground portions of the plant, beginning usually with the upper ends of the roots and gradually extending downward. Soon after the tubers are attacked they become wrinkled and the surface becomes covered with innumerable pimples, while the interior of the potato assumes a dry, powdery consistency. Fig. 58, a shows a portion of a typical tuber affected with dry rot.

Dry Rot Fungus. (Phoma batatae, Ell. and Hals.).

The fungus which is the real cause of the dry rot penetrates the tubers and draws therefrom its nourishment. The vegetative part of this fungus is composed of slender, thread-like filaments which grow rapidly and soon form small cavities in the skin of the potato just below the surface. These are represented on the surface by the pimple shown in Fig. 58, a while b in the same figure, shows the cavities in section and somewhat magnified; c represents one of the cavities still more highly magnified; it is a flask-shaped cavity with a rather short neck and dark wall, within which are produced the spores of the fungus. The spores are borne on slender stalks, which are pushed out from the vegetative part of the fungus into the flask-like cavities, d, representing some of the flasks cut horizontally, while e shows, highly magnified, some of the spores and the end stalks upon which they are borne.

Remedy.

Since the diseased tubers may be easily detected by their pimply appearance, it is not difficult to separate them from the sound potatoes. This step should be taken as soon as the tubers are gathered, and all diseased roots should be burned. Care should be taken that these diseased roots are not left in the field, as this will undoubtedly fill the soil with spores, and thus insure an attack on the succeeding crop.

Scurf.

Appearance of Disease.

Scurf is found only in the underground portion of the sweet potato plant, and begins as a tiny, light brown speck upon the surface of the tuber. This speck gradually enlarges until possibly the whole tuber assumes a rough appearance and a dark color, and if the attack is severe, the tuber appears somewhat shrivelled, Fig. 59, a. If we cut one of the affected potatoes, we shall see that the disease is confined to the surface of the tuber, and that the interior is still edible. Hence, while the disease does not destroy the crop it greatly decreases its market value.

Scurf Fungus: (Monilochaetes infuscans, Ell. and Hals.)

In Fig. 59, b are shown some of the cells from the surface of a diseased tuber, and also several of the fungus filaments. These filaments, which are composed of chains of cells, as shown in the figure, penetrate the skin of the tuber, and grow rapidly among the surface cells. The fungus draws its nourishment from the cells of the potato, thus causing the surface to shrivel and turn dark.

Some of the fungus filaments are pushed out, as shown in b, so that they extend above or lie upon the surface of the tuber. One of these filaments still more magnified is shown at c. This part of the fungus turns brown and gives additional color to the diseased portion of the potato. It is from this portion of the fungus lying outside of the potato that the spores are produced.

Remedy.

Close examination should be made of the roots from which the sprouts are to be produced, in order that the disease may be avoided. It is probable that soil and weather conditions have considerable to do with the extent of damage done by this pest, although it is clear that the fungus must be present in order to produce scurf. Hence, if the spores are in the soil, it would be advantageous to rotate crops.

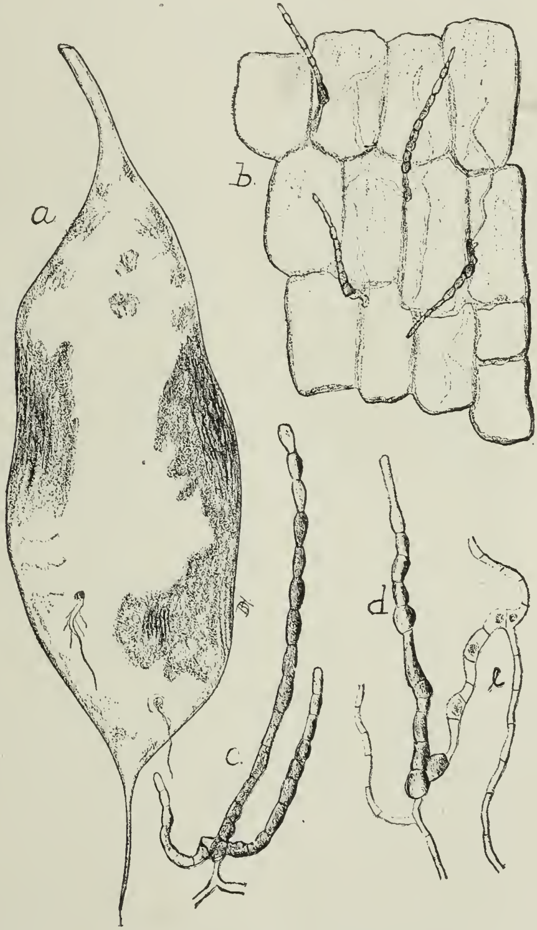

Figure 59.—Scurf. a, diseased potato; b, magnified surface; c, d and e, filaments of fungus. (After Halsted).

Leaf Mold.

Appearance of Disease.

As the name implies, this disease attacks primarily the leaf of the sweet potato, although it may attack the stem also. While it affects the underground portion in an indirect way, the damage done in reducing the number and size of the tubers is often considerable, since the whole plant depends upon the leaves and stems for the production of food material. In the first stages of the disease, the leaves assume a pale, sickly color. This is followed by the appearance of brown spots upon the upper surface, and white patches (spore masses) upon the under surface of the leaves. The leaf in Fig. 60, a shows several of the spots produced by this disease.

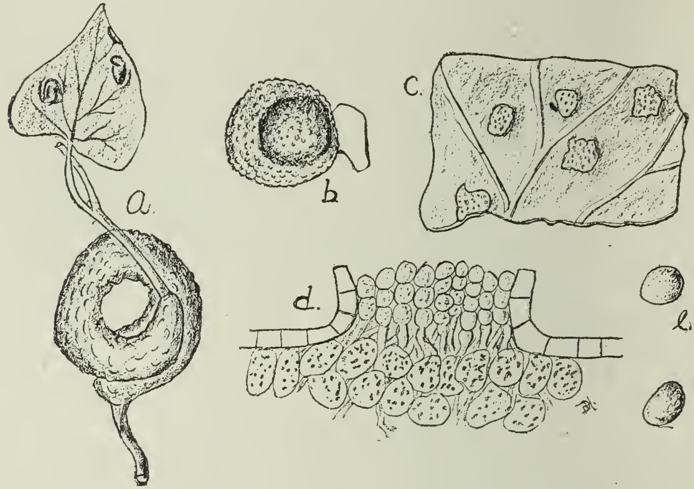

Figure 60.—Leaf Mold Fungus. a, leaf and vine affected; b, winter spores; c, portion of leaf affected; d, section through spot: e, summer spores, highly magnified. (After Halsted).

Leaf Mold Fungus: (Cystopus ipomocae—panduranae.—Farl.*)*

The vegetative part of this fungus is composed of fine filaments which grow among the leaf cells, absorbing from the host plant the nourishment necessary for the growth and development of the fungus. These filaments increase rapidly and break through the surface of the leaf, as shown at d, and on the ends of the filaments thus exposed to the air and light are formed numerous spores. Two of these spores more highly magnified are shown at e. They are comparatively thin-walled, and under favorable conditions will soon germinate and produce new fungi. The fungus which causes Leaf Mold is not confined to the sweet potato, but may attack a large number of allied species. While growing upon some of these closely related species a second form of spores is produced. Owing to the thick walls which these spores possess, they are able to resist the external weather conditions and thus to live over from one summer to another. This second class of spores, called winter spores, is produced in the swellings which appear upon the stems, as shown in Fig. 60, a. When these swellings break up in the spring, the spores are set free, and as soon as conditions are favorable, the fungus will attack any of the related plants with which they come into contact.

Remedy.

Destroy all the worthless species of the morning-glory family, of which the sweet potato is a member, so that none of the winter spores may be produced. At the first indication of this disease upon the sweet potato plants, spray with Bordeaux mixture to prevent its spread.

Summary.

All the diseases described in the foregoing pages are produced by small parasitic plants called fungi. A fungus is composed of two parts, viz., vegetative and reproductive. The vegetative part is composed of thread-like structures which are hollow, and which grow in or on the tissues of the diseased plants. The reproductive part consists of small, round or elongated bodies, called spores, which have the ability under favorable conditions to produce new fungi. The spores are produced in different ways by different fungi, and some of the fungi are able to produce spores in several different ways. Some spores are much more resistant than others and are capable of retaining their vitality for several years if the conditions for germination and growth are not favorable.

Black Rot:—Both stem and root liable to be attacked by this disease. Causes the diseased part to turn black, as the name signifies. May attack the young sets in the bed or it may not appear until the plants are in the field.

Remedy:—Discard all diseased sets, spray with Bordeaux mixture if an attack is feared, and do not plant in the same field where the disease appeared last season.

Soil Rot:—Attack is confined to the roots and tubers, giving to them the appearance of a string of beads of irregular size and shape.

Remedy:—Rotate crops. Treat the soil with sulfur four hundred pounds to the acre, sowed broadcast, and worked in. To the sulfur may be added with advantage the same amount of kainit.

Soft Rot:—Attacks tubers, usually after they are stored. Tubers shrivel. Black masses when skin is broken and disagreeable odor.

Remedy:—Avoid bruising the tubers, store in dry places at a temperature of about 70 degrees, remove and burn diseased tubers as soon as they begin to decay.

Stem Rot:—Dark lines appear on the stem just at the surface of the ground. Vine turns yellow, then black throughout, unless rooted at some node, beyond which it remains green. Disease extends downward, and causes upper part of tuber to decay. Short shoots from partly decayed tubers.

Remedy:—Rotate crops. Use only vigorous sets.

White Rot:—Attacks tubers only, giving them a white, chalky appearance.

Remedy:—Rotate crops. Use only vigorous sets.

Dry Rot:—Attacks underground parts only, giving to them a wrinkled, pimply appearance. Interior of diseased tubers becomes dry and powdery.

Remedy;—Gather and burn all diseased roots at the time the crop is harvested.

Scurf;—Attacks underground portion only, giving to them a rough, brownish, and sometimes a shriveled appearance.

Remedy;—Discard all diseased tubers in producing sets, and rotate crops.

Leaf Mold;—Leaves become sickly, brown spots appear upon their upper surfaces, and white spots upon the under surface.

Remedy;—Destroy all related weeds. Spray with Bordeaux mixture.

Note;—All sweet potato growers who are troubled with any diseases of this plant will confer a favor upon the writer by communicating with him in regard to the matter.

In conclusion, the writer wishes to express his sincere thanks to Prof. B. D. Halsted, of the New Jersey Experiment Station for the cuts used in this bulletin, and also for other assistance rendered.

PUBLICATION

OF THE

Maryland Agricultural Experiment Station.

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" " 56, June, 1898, Wheat, Winter Oats, Barley and Lime Experiments.
" " 58, Aug., 1898, The Hessian Fly and Wheat Diseases.
" " 59, Jan., 1899, Sweet Potato Insects.

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The
Sugar Beet
In Maryland.

BULLETIN No. 61
OF THE
MARYLAND AGRICULTURAL
EXPERIMENT STATION,
COLLEGE PARK, MD.
JUNE, 1899.

THE

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THE MARYLAND
AGRICULTURAL EXPERIMENT STATION

BULLETIN No. 61. **JUNE, 1899.**

The Sugar Beet in Maryland.

By H. W. Wiley, Chief Chemist U. S. Dept. of Agriculture.

HISTORICAL.

The establishment of a beet sugar factory in Wilmington, Del., in 1879, and the subsequent financial losses attending the venture, discouraged the Maryland farmers from undertaking an investigation of the possibilities of sugar beet culture in their State. Had the factory at Wilmington met with success, it would have been a proof of the possibility of establishing a successful beet sugar industry in Maryland. The great similarity of soil and climate between the two states indicates that what is true in a general sense of one locality is applicable to a greater or less extent in the other. Nevertheless the general interest which was aroused in connection with the beet sugar industry, at the time of the establishment of the factory at Wilmington, had its influence in Maryland.

Shortly before the time mentioned above, the Maryland Farmer, for 1874, Vol. 11, page 70, recommends that the sugar beet be cultivated in Maryland for cattle food. In the same journal for May, 1874, page 130, directions are given for the planting of sugar beet seeds. It is recommended that these seeds be planted before the 10th of May,that they be soaked before planting and that the rows be rolled, after sowing with a drill, by a hand roller, in order that the earth be pressed about the seeds, thereby hastening germination. The same journal for the month of June of the same year, has an article on the culture of the sugar beet and its value as a cattle food. This suggests that the sugar beets be thinned in the rows until they are about a foot apart and that in plowing the earth be thrown against the plants. Reference is

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Note: All the experimental work on sugar beets conducted by this Station has been in co-operation with the Division of Chemistry of the United States Department of Agriculture. The preparation of this matter for a bulletin has been authorized by the Secretary of Agriculture and Office of Experiment Stations.

H. J. PATTERSON, Director.

made to the European practice of level culture, but it is stated that with such culture the beets are apt to grow out of the ground. The yield of sugar beets in England is reported at the rate of seventy-two tons per acre, which is doubtless a wild exaggeration. The sugar beets and other root crops, it is stated, are essential to success in raising and fattening cattle and as a healthful food for milk cows, making a palatable change of diet from dry hay and grain. They also greatly promote the flow of milk in winter.

It is recommended on page 132 of the same journal for 1875, that land be prepared for sugar beet culture by fertilizing with 250 pounds of good superphosphate, and that a mixture of plaster, salt and ashes or fine bone dust, at the rate of about twenty bushels per acre, be applied on top of the soil after the planting is finished. It is recommended also to allow the plant to reach the height of six inches before thinning, and that in the thinning process the plants be transplanted to the vacant spaces in the row. It is stated that beets do well when transplanted, which is hardly in harmony with modern experience. On page 79, of the Farmer for the same year, it is stated that in Austro-Hungary from twelve to fourteen tons of sugar beets are produced per acre, yielding an average of thirteen per cent of sugar. A cut of a section of a sugar beet is given, showing the portion which is richest in sugar. It is stated that beets weighing about one pound are to be preferred. A line is also shown in the cut indicating the point at which the crown should be removed. Reference is made to the use of the pulp of the beet sugar factories for feeding cattle. It is recommended that from sixty to seventy pounds of pulp be fed to each animal with from six to eight pounds of meal per day. The most successful beet production, for sugar making purposes, is stated to have been obtained where the rows were sixteen inches apart and the plants six inches apart in the rows. A fertile loamy soil is best.

In the issue of the Farmer for July, 1877, Mr. Burnett Landreth gives some statistics in regard to the culture of the sugar beet in Europe. He states that the average production of beets reaches as high as ten tons per acre, yielding an average of over one ton of sugar. In Germany the average of sugar extracted is 9 1-10 per cent. The editor makes the following comments on Mr. Landreth's statements: "It is a great and profitable industry, but as has frequently been shown in the Maryland Farmer, watermelons are a more profitable crop to raise for making sugar." It is rather strange that the unfitness of watermelons for sugar making purposes was not known at that time.

In 1876-77 Delaware appropriated money to be expended in premiums, amounting in the two years to $1,800, and the result was the subsequent establishment of the sugar factory at Wilmington. An active interest was taken in this matter in many localities, particularly by the people of Baltimore, Md., but no attempt was made to grow the beet on a large scale for sugar making purposes nor to establish a factory.

In the Maryland Farmer for August, 1878, there is found an article by George M. Powell on beet sugar, in which it is stated that, "There is no material subject now engaging the attention of our countrymen of more vital importance than beet sugar." On page 271 there is an article, copied from the "Evening News," of Baltimore, entitled, "Probable introduction of a new and important industry in Maryland." It is stated that "The Pacific Slope and the Atlantic Slope and the Eastern States all have soils which have proved highly suitable to the growth of the sugar beet. Many localities in the Soutern States, where this root can be grown, may be included." * * * "In Europe, in California and in Maine, indeed, everywhere it has been tried, the growing of the true sugar beet and its manufacture into sugar has proved profitable to the growers and highly remunerative to the capitalist who invested in the manufacture." In commenting on this article, the editor of the Maryland Farmer said: "We hope that the manufacture of sugar from beets grown in Maryland, will be an accomplished fact before the year 1879 closes."

In the issue for October of the same year, is a paper on "Beet Sugar" by George May Powell, which was read before the Agricultural Section of the American Institute, in New York City, on August 27th. As long ago as 1878, it is seen from a perusal of Mr. Powell's paper, the newspapers were making statements that the simple apparatus used in the manufacture of cider and in making sugar from maple sap, are sufficient for making sugar from beets. He, however, shows the falsity of such statements and also points out the failure which attended the attempts of making sugar out of maize stalks. Mr. Powell advises the establishment of drying kilns in different parts of the country, where beets can be dried and the dried chips sent to sugar refineries for sugar making purposes. Mr. Powell had a very extended idea of the areas suitable to beet culture in this country. He says: "From the Canada line almost down to the Gulf of Mexico good sugar beets can be raised. * * * The mountainous western parts of the Carolinas, and the eastern parts of Kentucky and Tennessee, as well as Maryland and the Virginias, are perhaps quite as good as the New England and Middle States. * * * In many, if not in all of these regions, beet sugar is soon to become one of the greatest of our national industries."

In the issues of the Farmer for November and December there is an interesting history of beet sugar in the United States, written by Mr. Ernest T. Gennert. An amusing letter is found on page 383 of the issue for December, 1878, from Mr. Andrew H. Ward. He says that, "the beet juice is boiled down the same as maple sap, sorghum or cane juice, requiring no more labor or skill, and can be done as economically on the above quantity (725 bushels) as on a large amount. It needs no costly machinery, such as centrifugals, hydraulic presses, vacuum pans, or filtration through bone coal, etc." Mr. Ward further says: "The present cider mills and cheese factories could add to their present machinery the pans or presses, as required, and by co operation on this, as in regard to other products, we can produce profitably all the sugar we need."

An article, quoted from the Baltimore American, in the issue of the Farmer, December, 1878, refers to the recent failure of the Calvert Refinery, and suggests that the present condition of affairs affords an opportunity to inaugurate the manufacture of beet sugar, and the success attained by all the nations of Europe that have embarked in this industry proves the practicability of the enterprise.

About the year 1879, interest in the beet sugar industry became general throughout the United States. This was largely due to the investigations made by the Department of Agriculture under the direction of Dr. William McMurtrie, who immediately before this had been the chemist of the Department. Dr. McMurtire was also the representative of the United States Depatment of Agriculture at the Paris Exposition in 1878. He was the author of a most interesting and valuable report on beet culture, which was published by the Department in 1879.

The venture in which the people of Maryland were most interested was the one started in Delaware. It was perhaps unfortunate from a superstitious point of view that the Delaware Beet Sugar Manufacturing Company was organized on April 1st, 1879. The directors were among the most influential men of the State and the first board consisted of Geo. G. Lobdell, William G. Gibbons, Lea Pusey, Geo. W. Bush, William G. Pennypacker, Geo. W. Stone and Alfred W. Warner. In an article published by the newspaper, Every Evening, of Wilmington, Del., it is stated that the directors did not deem it necessary to build their factory until the first crop of beets was raised. It is further stated that the company intends manufacturing sugar from dried beets, using only such green beets as may be grown contiguous to the factory. An amusing illustration of the popular ignorance concerning beet manufacture is shown, where, it is stated, "Another advantage derived from using the dried beets is that they do not require evaporation." The beet seed employed was known as the "German Imperial," and the capacity of the proposed factory was fifty tons of beets per day, turning out five tons of sugar per twenty-four hours. The Maryland Farmer, in commenting on the above article, asks: "How long is it to be before Marylanders will engage in this new and great national enterprise?" In the light of history I have no doubt that the Marylanders are extremely glad that the time of their engaging in this new and great national enterprise was postponed.

The Aegis and Intelligencer, of Belair, reports a meeting of the farmers of Harford county, Maryland, held on the 5th of April, 1879, at the house of Mr. C. C. Kinsey, W. A. Heaps presiding and W. Scott Whiteford acting as secretary. It was proposed at this meeting to raise $15,000 as capital for the erection of a beet sugar factory in Harford county, consisting of 750 shares, at $20 each, one-third of which was to be payable in beets. This seems to have been the first organized meeting in Maryland to secure the location of a sugar factory.

The Baltimore American for September, 1879, contained a leading article on the beet sugar industry, urging its establishment in Maryland. It was urged that the prices of coal and of all the ingredients used in refining sugar were as cheap in Maryland as in Germany or France and that, "above all, the nature of the soil in Maryland and Virginia is believed to be better adapted for raising the sugar beet than that of Germany."

According to the Belair Aegis and Intelligencer of September, 1879, Mr. Richard B. McCoy, who had been president of the Harford County Sugar Beet Association, visited Wilmington in September, 1879, in the interests of the Harford County Association. Mr. Lea Pusey made an offer to him to buy beets in the green state from the Harford County farmers, at the price of $4 per ton, to be delivered at any of the stations of the Philadelphia, Wilmington and Baltimore Railroad. A contract was made with that railroad to deliver beets from Harford county to Wilmington, at a reduced rate of freight. It is evident from the report given that considerable quantities of beets had been planted in Harford county, since it is stated that the crop promised to be a good one, although the dry weather had operated against it.

In the Baltimore Sun of October, 1879, it is claimed that, "Baltimore is in a superior position for a beet sugar centre. She has great advantages over all German ports. Maryland, owing to its long growing season could give larger growth and more saccharine value to the beets than Germany."

In the same journal data are given concerning the cost of drying the beets. It is evident from the literature of the time, that the prevailing opinion in regard to this industry, was that the beets should be sliced and dried before shipment to the factory. This is shown by an article in the Baltimore Sun, copied in the Maryland Farmer for July, 1879, as follows: "It is wonderful that the old clumsy chemistry of raw beets is not universally abandoned. Hereafter instead of raw beets full of bitterness and with only 8 per cent of sugar, our mills will use dried beets, yielding 50 per cent of sugar. Instead of costing 7 cents a pound to make the sugar, half that sum will cover the cost. Instead of our mills working, at most, three and a half months of the year, they can be kept busy for twelve months. Instead of being dependent upon the vicissitudes of the weather for every year's crop, a supply can be held in stock for two years ahead. Baltimore may yet be destined to outrank New Orleans as a mart for sugar."

A correspondent of the Maryland Farmer, under date of March 19th, 1879, urges the advisability of growing sugar beets on the Eastern Shore and expresses the idea that it would be a great thing for all classes and that he intends trying them on an acre or more and hopes that he may be able to make a great deal of sugar for home use, using the refuse to fatten his cattle.

Mr. Andrew H. Ward, in the Maryland Farmer, for February, 1880, page 42, gives the cost of a sugar factory capable of working 30 tons of sugar beets per day. The total cost of the factory is given as $3,500. He estimates that such a factory would produce in a season 480,000 pounds of sugar! It is evident from the above that the days of rosy prophecy with dreams of immense pecuniary returns began early in the history of the sugar beet industry in this country.

The farmers in Harford county seem to have taken the most interest in the matter in September, 1880, when Mr. R. B. McCoy, together with other farmers of Harford county, reported experiments with the culture of the sugar beets. He stated that the chief difficulty encountered was getting the beets to the factory, the nearest one being at Wilmington, Del., and expressed the hope that a factory might be established at Havre de Grace. He stated that the soils in lower Harford county were fertile and capable of growing high grade beets.

With the failure of the factory in Wilmington, the interest in the sugar beet industry in Maryland seems to have completely died out. The next reference to the subject is in the Maryland Farmer for 1884, and this consists of statistics showing the enormous increase of the beet sugar industry in Europe and the consequent falling price of sugar. In the next month's issue, namely, October, 1884, the Farmer says: "The manufacture of beet sugar in this country so far has proven anything but a success. The chief cause of failure, according to manufacturers, is the unwillingness of farmers to grow beets in sufficient quantities. Only two beet sugar factories are at present in operation in North America, one in the Province of Quebec and the other in California." No further references to the culture of sugar beets in Maryland until recent years are found in the agriculture literature accessible.

In 1890, with the cooperation of the Chemical Division of the United States Department of Agriculture the Maryland Station grew quite a large quantity of sugar beets, with results which were quite favorable, in so far as regards the percentage of sugar. The data in relation to this work are found in the Third Annual Report of this Station, published in 1890, which is of such interest as to justify its insertion here.

"Two and one-half acres of land were cultivated in sugar beets during the season of 1890, for the Chemical Division of the United States Department of Agriculture. This was in connection with the general sugar investigation of the Department, and with special reference to the saccharine quality of the different varieties tried here, and the effect thereon of the various commercial manures applied.

"The land used was a portion of the sorghum field cultivated for the Department in 1889, and described on pages 148-49, in the Second Annual report of this Station. It was the central portion of that field which was selected for beets. The five varieties of beets were planted on long, narrow, half acre strips, running east and west, these were divided into twenty plots, running north and south, receiving as many different fertilizers or combinations of fertilizers. The latter were the same as applied to the same plots for sorghum, the year before, it being hoped that the special effects would be thus intensified. The five (5) varieties of beets were as follows: No. 1, Dippe's Vilmorin; No. 2, Simon Le Grand's White Improved; No. 3, Bulteau Desprez's Richest; No. 4, Florimond's Desprez Richest; No. 5, Dippe's Kleinwanzlebener. These were sown in rows 700 feet long and 2 feet apart.

"The soil was plowed and subsoiled, being thus worked at least a foot in depth, and repeatedly rolled and harrowed, until an excellent seed-bed was prepared. Seed was sown June the 7th, with a Planet Junior drill. A very heavy rain soon followed and packed the earth so hard as to greatly interfere with the vegetation, resulting in a poor 'stand.' Cultivation was thorough, with double wheel or push hoes and common hand tools. An attempt was made to improve the stand and make it more even, by transplanting, but the July drouth destroyed the plants thus moved. The crop was light and the size of the roots averaged rather small.

"All examinations of the beets were made at the Chemical Division of the Department of Agriculture, to which, under instructions received, sample roots were sent, every other day, from October 24th to December 2d. Every shipment represented all five varieties, as grown upon one fertilizer plot. At each shipment twenty or thirty average beets were pulled, and from these, two roots selected as fairly representing a variety; ten roots were thus sent, each time and delivered at the Department the day they were pulled.

"The results of the analyses were reported from the Department as fast as made. These roots properly belong to the Chemical portion of the report, but a summary is appended of the average results, and this shows the size and quality of the beets, of the different varieties.

TABLE VIII.—Size and Quality of Sugar Beets:

No.	Variety.	Weight of Beets: Averages in Ounces.	Average Per Cent of Sugar	Average Co-efficient of Purity.
1	Dippe's Vilmorin...........	11	13.4	83.6
2	Simon LeGrand's White Improved..	10	13 0	81.0
3	Bulteau Desprez' Richest..........	11⅓	11.6	78 9
4	Florimond's Desprez' Richest.......	10⅓	10 8	76.2
5	Dippe's Kleinwanzlebener...........	8½	12.3	78.2
General Average		10¼	12 2	79.7
The best lot of beets averaged		23	20.9	94 7

"The results of the twenty different fertilizer plots, did not vary enough to make it worth extending the records.

"The general crop was harvested and stored by pitting, before any hard freezing weather. The five varieties were kept by themselves, but (under orders from Washington) no distinction made between roots of same variety grown with different fertilizers.* E. H. B."

The detailed results of the culture of the sugar beet in Maryland are found in Bulletin No. 30 of the Department of Agriculture, pages 15, 16 and 17. Eighty-one samples of beets were analyzed altogether, with the following results:

Mean weight of the beets	416 grams.
Mean content of sugar in the beets	12.3 per cent.
Purity	79.7.

The results above obtained are probably better than any others that have been secured in the State of Maryland on so large a scale. In a few instances the percentage of sugar in the beet was abnormally high, in one case 21 per cent. The beet in this case weighed only 90 grams. In a few instances, however, the percentage of sugar was very high, together with a fine weight of the beet, as, for instance, in one case where the percentage of sugar was 18.9, the weight was 375 grams and the purity 94.8.

In the Annual Report for the Maryland Agricultural Experiment Station for 1891, page 376, a short report is given on sugar beets. An attempt was made to grow an acre for stock feeding. The soil was a medium clay, well dressed with stable manure. Considerable difficulty was experienced in getting the seed to germinate. By transplanting, about one-fourth of an acre was secured. Evidently the difficulties experienced were far greater than in the previous year.

At the Department of Agriculture in 1891, only two samples of beets were received from Maryland. These were extremely poor, the average amount of sugar in the beet being 7.75 and the purity of the same only 68.5. The samples were both grown in Prince George's county, the mean weight of the beets being 16 ounces.

The reviving interest in beet culture was reflected also about this time in the Maryland Farmer, where a letter published in September, 1891, page 31, calls attention to the value of the large tracts of sandy, loamy soil in Maryland for the purpose of growing sugar beets. It was suggested that the State make an appropriation of thirty thousand dollars for a thorough trial of this industry.

The increase of the interest in Maryland, however, was very slight, since in the distribution of beet seed in 1893, by the Department of Agriculture, when 2,428 packages were sent out, only 13 were sent to Maryland.

In the Maryland Farmer for July, 1896, a subscriber asks if there is any record of the number of bushels of sugar beets, raised to the acre in the State of Maryland. Gen. Geo. S. Brown, of Baltimore, it is stated, raised on a quarter of an acre of his farm, a number of years ago, 223 bushels, equal to 892 bushels to the acre:

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* Note: Since this report was prepared. the Chemist of the Department has found the sugar beets raised at this Station of such an exceptionally high quality, as compared with those grown in other parts of the country, that he has ordered all the roots remaining here to be sent to the Government Beet Sugar Station in Nebraska, to be there used for producing seed in 1891; a composite sample of the soil from our beet-field has also been asked for by the Chemist of the Nebraska Station. This seems to justify making this record, and also further efforts in growing sugar beets upon the farm of the Maryland Agricultural College. H. E. A.

In 1897, 29 samples of beets grown in Maryland were analyzed in the Division of Chemistry, of the Department of Agriculture. These beets were from the following counties:

Anne Arundel	4
Baltimore	3
Frederick	2
Harford	4
Montgomery	4
Prince George	3
Talbot	3
Washington	5
Wicomico	1
Total	29

The mean results of the analyses were as follows:

Mean weight	19	ounces
Mean per cent of sugar in the beet	11.41	per cent.
Mean purity coefficient	79.1	

"All the analyses of the samples of beets* grown in Maryland were made in the laboratory of this Division, the Agricultural Station at College Park, not having undertaken any work of this kind. The whole number of samples received from the State was 29. The mean size of the beets was 19 ounces, the mean percentage of sugar in the beets 11.4, and the mean purity of the juices 79.1. In respect of size, the samples from Maryland are about the mean. The purity of the juice is almost up to the minimum standard, but the percentage of sugar in the beet is about 0.6 less than is advisable for manufacture.

"In regard to climatic conditions, as has before intimated, the State of Maryland occupies a somewhat peculiar position. There is a considerable area along the Eastern Shore, next to the ocean, where the average summer temperature is 71 degrees. In the western part of the State, after a long deflection to the north, the isotherm of 71 degrees may again be found. Lying immediately south of the isotherm of 71 degrees, in the northern portion of Maryland, are found some very fine valley lands, where the conditions of culture may be considered favorable. These lands are underlaid by limestone, which, in many cases, comes to the surface. Theoretically, they are a little too warm for the most successful culture, but lying so near the favorable thermal belt there may be reasonable hopes of successful culture in many localities. In the western portion of the State, where the thermal conditions are favorable, we find the mountain ranges, and the low temperature of the summer is due to the high elevation. The quantity of table lands upon the tops of the mountains, however, is not sufficiently great to warrant the expectation of the founding of a great industry, but there is no doubt of the possibility of growing very rich beets on these table lands. In general, it may be said, that the State of Maryland is not very favorably situated for the culture of sugar beets, but there are circumscribed localities within the State where it is desirable to conduct further experiments. It is, therefore, earnestly hoped that the Agricultural Experiment Station of the State will make a more careful agricultural survey of the possibilities of the culture of sugar beets therein."*

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*Refers to samples in preceding table.

During the season of 1898 a number of experiments in the growth of sugar beets in Maryland, was conducted, under the joint auspices of the Maryland Agricultural Experiment Station and the Department of Agriculture. Thirty-one samples of beets were received for analysis, grown in different parts of the State. The average weight of the samples was 22 ounces, the mean content of sugar 10.4 per cent and the mean purity 76. The following table gives the names and locations of the growers of the samples, together with a detailed analysis of each sample:

The best sample was grown by Charles D. Reaves, of Baltimore. His samples showed the highest sugar content and the highest purity. Other samples showing a high sugar content were grown by L. Hegmaier, of Cumberland, and Horace Venables, of Mardella Springs. The average excellence of the beets was not quite equal to that of some other years, but the average size was entirely satisfactory.

The highest content of sugar in any one sample was 15.7 per cent, and the highest purity coefficient was 85.7.

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*Bulletin No. 52, Division of Chemistry, Department of Agriculture, Pages 77-78.

REPORT OF SUGAR BEETS GROWN IN MARYLAND, 1898.

Name.	Locality.	Average Weight.	Sugar Per Cent.	Coefficient of Purity.
Chas. F. Welenourky..	Tannery..........	29 ozs.	.8	74.1
Edwin J. Derickson ...	Berlin.....	28 "	8 8	80.2
Geo. S. Willison	Cumberland.....	23 "	12.3	80.1
J. B. W. Gardiner......	Bryantown........	36 "	10.0	74.0
John T. Rutter.........	Woodlawn,.......	29 "	10.7	78.5
U. M. Stanton..........	Grantsville......	23 "	13.1	83.6
N. H. Fooks............	Preston...........	32 "	9.1	75.0
L. Hegmaier...........	Cumberland.	46 "	10 6	74.7
L. Hegmaier...........	Cumberland.	23 "	13 8	81.0
Edw. F. Tucker	Araby...	23 "	6.6	66.7
W. S. Davis............	Clements	14 "	8.4	71.0
Horace Venables......	Mardella Springs	13 "	13.9	78.5
Geo. H. Payne..........	Compton.........	9 "	10.7	71.1
H. J. Mitchell	Pocomoke City ..	20 "	8.6	75.0
J. B. W. Gardiner	Bryantown........	25 "	9.5	73.5
John T. Best............	Frederick........	28 "	10 5	75.2
Chas. C. Webster.......	Thurmont........	30 "	9.7	75.0
Chas. C. Webster	Thurmont........	22 "	9.1	72.6
W. T. Stanton..........	Grantsville	19 "	12.3	77.7
John T. Best............	Frederick........	16 "	9.7	76.1
Walter Williams........	Poolesville.......	7 "	10.6	
Rev. R. H. Murphy.....	Port Republic....	16 "	10.9	81.3
T. Benton Daugherty...	Dublin...........	17 "	8.8	72.7
Henry Strite............	Hagerstown......	27 "	9.6	70.1
Charles D Reaves......	Baltimore........	16 "	14.2	84.7
Charles D. Reaves......	Baltimore........	13 "	13.6	83.1
Wm. A. Smith..........	Woodwardsville..	27 "	7.2	72.4
N. D. S. Parray.........	St Leonard's.....	11 "	8.1	74.6
Alex. Bowling..........	Bryantown........	13 "	11.9	81.7
Alex. Bowling..........	Bryantown...... .	11 "	10.9	77.2
D. C. Kemp.............	Frederick........	23 "	10.4	69.0
Total No. of Samples 31	Means	22	10.4	76.0
	Maxima	46	14.2	84.7
	Minima	7	6.6	66.7

ADAPTABILITY OF THE SOIL AND CLIMATE OF MARYLAND TO SUGAR BEET CULTURE.

In the résumé, which has been given above of an historical nature, showing what has been accomplished with sugar beets in Maryland, it will be noticed that the actual analytical data are few in number and that most of the interest which has been manifested in Maryland has been in the discussion of the problem rather than in its elucidation. A few additional words, therefore, are necessary in regard to the adaptability of the soil and climate of Maryland to the raising of sugar beets and a comparison of the possibilities of successful beet culture there with some of the other portions of the country.

It has been established by very extensive investigation and experiment, in this country, that the southern limit of sugar beet culture, where particularly high grades of beets are desired, is practically the isotherm of 71 degrees F., mean temperature for the summer months of June, July and August. This isotherm touches the State of Maryland in two places, first, on the coast line on the Eastern Shore, passing in an almost due north and south direction, and after making a long detour to the north, reaching almost to Albany, this isotherm turns in a southwestern direction and enters the State of Maryland again in the extreme western portion, coming into the State from Pennsylvania at a point on the border almost northwest of Williamsport. It is thus seen that the limits of most favorable temperature, exclude the greater part of the State from the area most suitable for beet culture. The data which have already been secured, show that beets of fair average quality can be grown in all parts of the State of Maryland, and a few instances have been cited where the beets produced were of exceptionally fine quality. It is evident, however, that upon the whole the climate of Maryland is too warm during the time specified to produce beets of the highest grade.

The character of the climate of the Eastern Shore, immediately adjoining the Atlantic Ocean, presents fairly favorable conditions, but that area is too small to warrant the assumption that a large industry could be established.

In Bulletin No. 52, (Revised) of the Division of Chemistry, the following statements are made on pages 27 and 28:

"EASTERN SHORE OF MARYLAND."

"The isotherm of 71 degrees enters Maryland at a point about the centre of the Atlantic Coast of the Eastern Shore, and runs north by northeast almost to Poughkeepsie, N. Y. It is evident, therefore, that the temperature conditions of this region are similar to those on or south of the isotherm of 71 degrees in other parts of the country, although here in this area the region lies to the west of this isotherm. Judged by this factor, and also by the mean annual rainfall, which is 40 inches for this locality, the cultivation of the sugar beet might be successfully inaugurated along the Atlantic Coast of the Eastern Shore; in fact, practically over the whole of the southern portion of the Eastern Shore of Maryland. The character of the soil in this locality is mostly sandy, and its natural fertility has been considerably diminished by long years of cultivation. There is no reason to doubt, however, the fact that with proper fertilization and cultivation the requisite degree of fertility for the production of sugar beets could be secured. The general tendency in this region is in the direction of a too high temperature and too few hours of sunshine. The above observations apply also to Accomac county, Va."

In the northwestern part of the State, where the thermal conditions are also favorable, the result has been brought about by the high elevation of the Allegheny Mountains. The contour of the land in this portion of the State, hilly and mountainous, is unfavorable to beet culture, and it is only on the high table lands of the mountainous regions that any adequate areas for beet culture can be secured. These are limited in extent, and, therefore, any expectation of establishing any considerable sugar beet industry in this locality must be abandoned.

The causes which produce these unfavorable conditions in Maryland are twofold. In the first place the southern latitude secures shorter summer days than obtain farther north. The mean length of the summer days, i. e., the hours of sunshine, excluding all clouds and fogs at Baltimore, Md.; Bay City, Mich.; Lille, France, and Madgeburg, Germany, is shown in the following table:

	Degrees	June	July	August
Baltimore, Md.	39 North	14.9 Hours	14.6 Hours	13.7 Hours
Bay City, Mich.	44	15.4 "	15.1 "	14.0 "
Lille, France	51	16.5 "	16.0 "	14.5 "
Madgeburg, Ger.	52	16.7 "	16.2 "	14.6 "

AVERAGE DAILY DURATION OF POSSIBLE SUNSHINE.

It is thus seen that the beet fields in the vicinity of Bay City, Mich., have nearly a half hour more sunshine than those in the vicinity of Baltimore, Md., while at Magdeburg the mean duration of sunshine is nearly an hour and a half greater than at Baltimore for the periods mentioned. Since the production of sugar is solely a function of the leaves under the influence of the sunlight, and the proper temperature, it is evident that the capacity for making and storing sugar in the beets grown near Bay City, is greater by far than that of the beets grown in the vicinity of Baltimore. Thus the thermal conditions not only act adversely by causing too high a temperature, for the most favorable storing of sugar, but in this country also act unfavorably by shortening the hours of sunlight, thereby restricting the activity of the cells of the leaves. If the temperature in the vicinity of Baltimore were exactly the same as that in the vicinity of Bay City, there would still be a distinct advantage secured by growing beets in the more northern locality. One of the chief reasons of the great success of the beet culture in the north of France and in Germany, is the great length of the days in these northern latitudes as well as the more equable distribution of temperature. The mean length of the summer days at Lille, France, is 15.67 hours, and at Madgeburg, the centre of the beet sugar industry in Germany, 15.83 hours. It is thus seen that there is a distinct advantage derived from an abundance of sunlight in the more northern localities.

Another point to be noticed is that the intense heat of the summer days in Maryland tends to harden the ground and to raise the temperature of the upper parts of the beets, to a degree incompatible with the maximum storage of sugar. The hot days also tend to ripen the crop prematurely,so that the dangers which come from a second growth due to autumnal rains, are greatly increased. A beet which has not quite matured by the latter part of September is not greatly injured by the heavy autumnal rains, which are usual at that season. On the other hand, if the beet be perfectly matured, an entirely new growth of the leaf system is established and this growth is largely at the expense of the sugar which has been stored. In this fact is found another reason unfavorable to the growth of beets in Maryland.

SOIL.

In regard to the soil of Maryland, little need be said. There are many areas of large extent where the soil is favorable to the growth of beets. The ideal soil is one which contains a sufficient amount of sand to prevent it becoming hard in summer, and yet has not enough to diminish the fertility of the soil. Such a sandy soil with a fair proportion of organic matter, and with a reasonably abundant supply of mineral plant foods, affords the best environment, in so far as the soil conditions are concerned, in beet development. The impermeable subsoil should not be too close to the surface, but at least from 18 to 20 inches below. The tap roots of the beets should meet with no very great obstruction within 18 or 20 inches of the surface. This enables them to grow straight down and to develop symmetrically, thus securing the maximum storage of sugar. There are many localities in Maryland where the limestone strata come to the surface, and where the depth of the soil overlying the limestone is not very great. It is evident that such a soil, although reasonably fertile, would not be suitable to beet culture, because of its lack of depth. There are also many very sandy soils devoted largely to the growth of market garden crops, which are not so well suited to beet growth, although the beet will stand a very large percentage of sand, if it be properly fertilized. Even these excessively sandy soils, therefore, will grow excellent beets, provided the crops are fed the proper quantities of mineral and organic foods in the fertilizers employed.

From a careful study of all the accessible data, taking into consideration the soil and climatic conditions, it is evident that no very favorable environment exists in the greater part of Maryland for beet culture. Where the soil conditions are favorable, beets can be grown having a sugar content of about 12 per cent. It is evident that beets of this quality would give an abundant yield of sugar, and if we were speaking of the conditions a quarter of a century ago, such beets could be grown and manufactured into sugar with the greatest profit.

On the other hand, it must be remembered that there are many places in the United States of wide extent, where, with the same attention, beets can be grown with an average content of nearly 15 per cent of sugar. Many such localities are found in northern New York, Michigan and Wisconsin, and many of a like character are found in the West along the Pacific Coast. It does not, therefore, seem the part of wisdom to attempt to establish a beet sugar industry in Maryland, where the product obtained would have to come in competition with that from the more favorable localities, to which attention has been called.

METHODS OF CULTIVATION.

It has been suggested that it might prove very profitable for Maryland farmers, especially those engaged in the dairy industry, to grow sugar beets for cattle food. The sugar beet has a distinct advantage over rutabaga, turnip or other common root crops, grown for feeding domestic animals, in having a much higher percentage of sugar and thus a greater fattening power. Sugar beets as a cattle food have proved to be very advantageous for dairy cattle, provided the roots are not fed in sufficient quantities to induce the formation of an excessive amount of fat. The yield, per acre, of the sugar beet, is not so great as any of the other root crops mentioned, but the actual amount of food material produced in a crop of ten tons of sugar beets is almost as great as in a crop of twenty tons of rutabaga or in thirty tons of turnips. There is, therefore, some economy gained by handling a crop smaller in amount, but possessing a higher concentration of food qualities. The high value of sugar beets as a cattle food might justly warrant a suitable degree of at least experimental culture for the purpose mentioned.

SELECTION OF SOIL.

In selecting the soil for the growth of sugar beets, even if raised for cattle feeding purposes, a sandy, loamy soil should be preferred. The soil should contain enough sand to prevent its baking after hard rains in the summer, and at the same time a sufficient quantity of organic matter and mineral plant food to nourish the crop. The sugar beet is a high feeder, and requires a much larger quantity of plant food, per acre, than a cereal crop. A soil above the average in fertility is therefore desirable for sugar beet purposes.

The contour of the soil should be reasonably level, since the culture of beets is not easily accomplished on hillsides or on rough ground.

The soil should have a reasonable depth and at least two feet or two and a half feet should intervene between the surface and any impenetrable medium, such as rock, hard impervious clay or gravel. For a like reason the permanent water line of the soil should not be too near the surface, since the presence of water would cause the tap root to rot and thus destroy the chief source of supply of the growing plant.

PREPARATION OF THE SOIL.

For the proper growth of sugar beets it is best that the field be ployed to a depth of eight or ten inches, and the subsoil to a depth of six inches more, in the autumn previous to the planting. Late November or early December, according to the severity of the weather, is a favorable time for the preparation of the soil. If the soil be plowed at an earlier date some catch crop, such as rye, should be sown, in order to protect the surface of the soil and to avoid the loss of nitrogen until the full advent of winter. In the spring, in case the catch crop has been sown, it should be plowed under to the depth of about three or four inches, at the earliest possible moment and the surface of the soil reduced to the proper tilth by harrows, cultivators or disk-harrows. It is highly important that the seed bed be in the best possible condition before planting.

FERTILIZATION.

Nearly all soils, especially those which have been under cultivation for a long time, require generous fertilization in order to produce a paying crop of beets. Barnyard manure should be avoided, or if applied at all should be applied the previous year in an almost rotten state. Mineral fertilizers can be applied in the spring and worked deeply into the soil by the time set for cultivation. From three to five hundred pounds of acid phosphate and from two to three hundred pounds of potash per acre can be profitably added. The nitrogeneous fertilizer may consist of the nitrate of soda, which, however, should not be in a greater quantity than from one hundred to two hundred pounds per acre. Nitrate of soda offers the immediate nitrogen necessary for the young crop. Later, nitrogen for the completion of the growth and the maturity of the crop can be supplied in the form of tankage,cottonseed meal or other similar nitrogeneous fertilizer, at the rate of from two to three hundred pounds per acre.

PLANTING.

The planting should be done as early as possible in the season. In Maryland the planting can even be accomplished in April, and the sooner the better. About twenty pounds of seed should be used per acre, and these are best planted by means of a drill in rows from eighteen to twenty inches apart. The seed should be covered lightly, not exceeding three-quarters of an inch in depth and less if the surface be moist and in good condition. The germs of the beet seeds are extremely tender and reach the surface with difficulty if too much earth be placed over them.

CULTIVATION.

Level cultivation should be practiced, the surface being kept well pulverized and free from weeds. The hoe is a very useful instrument in early cultivation.

THINNING.

When the young beets begin to show four leaves, they should be thinned, leaving from six to nine inches between the plants in the rows, according to the fertility of the soil. Since often two or three sprouts come from the same seed, great care should be exercised in removing the extra plants, so as not to remove the whole bunch from the soil. When the leaves of the beet fully cover the surface of the soil, about the middle or end of July, the cultivation may be suspended.

HARVESTING.

The beets are best harvested by passing the lifter underneath the roots, which breaks the tap roots and loosens the beets in position. The beets are then removed by hand, by means of the leaves. The leaves may be removed and make an excellent cattle food.

SILOING.

When beets are to be kept for winter use they are placed in silos, after the removal of the leaves, and protected in the same manner as potatoes, turnips or other root crops under similar conditions.

FEEDING.

For feeding purposes, the beets should be washed to remove the dirt and, to aid mastication, should be cut into pieces of convenient size.

Full details in regard to planting and cultivating beets and a description of the agricultural implements used are found in Revised Farmers' Bulletin No. 52, which can be had free of charge by application to the Secretary of Agriculture, at Washington, D. C.

THE SUGAR BEET IN MARYLAND.

Conclusions:

1. The sugar beet has been cultivated in Maryland with more or less regularity since the year 1874. In 1879 and '80 a great interest in the sugar beet industry was manifested in the State and attempts were made to establish factories, but without success. At that time it was the general opinion among the agricultural papers and farmers of Maryland that the soil and climate of the State were as well adapted to the growth of sugar beets as any of the areas of Europe.

2. With the reviving interest in the industry in 1890 and '91 the Maryland Agricultural Experiment Station collaborated with the Department of Agriculture in the growth of the usual varieties of beets. It was proved that beets of fairly good size and content of sugar could

be grown in the State. The average content of sugar secured in these experiments was a little over 12 per cent, with a purity of a little less than 80. The yield per acre, however, was low and many of the beets were too small for profitable handling.

3. The possibility of the successful culture of the sugar beet in Maryland as a cattle food, is worth a practical demonstration. The sugar beet is a much richer cattle food, ton for ton, than any other common root crop and while the yield per acre is less, the available nutritive material is quite as great.

4. There are many areas in Maryland where the soil, both in its composition and contour is favorable to beet culture, and where, by reason of location, the freight on fertilizers would be low. It is probable if the soil conditions alone were to be considered, that Maryland could successfully compete with other States of the Union in the growth of sugar beets.

5. The climatic conditions of Maryland are distinctly unfavorable to the growth of beets of maximum sugar content and purity. The mean temperature for the months of June, July and August is too high to secure the best results and the mean hours of sunshine for those months are too short. The most favorable climatic conditions for beet culture are secured in high northern latitudes, where summer days are long. The northern limit for the growth of sugar beets is determined only by the shortness of the season preventing maturity. The hot and dry days of the Maryland summers hasten the beets to premature maturity and thus increase the dangers arising from a second growth in the period following the autumnal rains.

6. In the present state of the sugar industry it has been established that Maryland cannot successfully compete in the manufacture of beet sugar with more favorable localities of the United States.

PUBLICATION

OF THE

Maryland Agricultural Experiment Station.

These bulletins are sent free of charge to any address upon application to the Director of Experiment Station, College Park, Maryland.

(Only the bulletins named below are available for distribution.)

Bulletin No. 1, June, 1888, History, Organization and Work of the Station.
" " 6, Sept., 1889, Commercial Fertilizers.
" " 12, March, 1891. Pig Feeding.
" " 22, Sept., 1893, Steer Feeding; A Well Balanced vs. A Poorly Balanced Ration.
" " 24, Feb., 1894, Composition of Commercial Fertilizers sold in this State.
" " 26, June, 1894, Tobacco.
" " 29, Dec., 1894, Further Investigations on the Soils of Maryland.
" " 31, March, 1895, Potato Experiments.
" " 32, April, 1895, The San Jose Scale.
" " 33, April, 1895, Horticultural and Agricultural Departments; Small Fruits Vegetables and Field Corn.
" " 34, July, 1895, Composition of Commercial Fertilizers sold in this State.
" " 35, Sept., 1895, Wheat, Barley, Oats and Hay Experiments
" " 36, Dec., 1895, Steer Feeding; A Well Balanced vs. A Poorly Balanced Ration.
" " 37, Feb., 1896, Composition of Commercial Fertilizers sold in this State.
" " 38, March, 1896, Potato Experiments.
" " 39, April, 1896, Spray Calendar.
" " 40, Aug., 1896, Composition of Commercial Fertilizers sold in this State.
" " 41, Sept., 1896, Tests of Methods of Preparing and Feeding Corn Fodder.
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" " 43, Dec., 1896, Report upon the Value of a New Corn Product.
" " 46, March, 1897, Corn and Potato Experiments.
" 47, June, 1897, Dairy Farming.
" 48, June, 1897, Some Common Injurious Plant Lice with Suggestions for their Destruction.
" " 49, Aug., 1897, Composition of Commercial Fertilizers sold in this State.
" " 50, Sept., 1897, Rust and Leopard Spot, Two Dangerous Diseases of Asparagus.
" " 51, Dec., 1897, Horse-Feeding; Tests of the Digestibility of Oats, Corn Hay and the New Corn Product.
" " 52, Feb., 1898, Composition of Commercial Fertilizers sold in this State.
" " 53, March, 1898, Special Investigation of the So-called "New" Horse Disease in Maryland.
" " 54, March, 1898, Tomatoes.
" " 55, May, 1898, The Black Peach Aphis, Cut Worms in Young Tobacco—Law Providing for the Suppression and Control of Insect Pests and Plant Diseases in Maryland.
" " 56, June, 1898, Wheat, Winter Oats, Barley and Lime Experiments.
" " 58, Aug., 1898, The Hessian Fly and Wheat Diseases.
" " 59, Jan., 1899, S [illegible] tato Insects.
" " 60, March, 1899, S [illegible] tato Diseases.

Experiments With Wheat, Corn and Potatoes.

BULLETIN No. 62
OF THE
MARYLAND AGRICULTURAL
EXPERIMENT STATION,
COLLEGE PARK, MD.

JUNE, 1899.

THE

Maryland Agricultural Experiment Station.

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Visitors will be welcomed at all times, and will be given every opportunity to inspect the work of the Station in all its departments

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The Bulletins and reports of the Station will be mailed regularly, free of charge, to all residents of the State who request it.

ADDRESS:

AGRICULTURAL EXPERIMENT STATION,
College Park, Maryland.

THE MARYLAND
AGRICULTURAL EXPERIMENT STATION

BULLETIN No. 62. JUNE, 1899.

Variety and Culture Experiments with Wheat, Corn and Potatoes.

Variety Tests of Wheat—1898.

The general plan of the variety test with wheat in 1898 was the same as reported in Bulletin No. 56, and in the main was a continuation of the work which had been in progress for a number of years. The varieties used in the test were those which were considered standard and the most promising grown in former years, together with such new varieties of late introduction as came to our notice, or upon which favorable reports had been received from various sections of this State.

The land used for this test was in corn in 1896, in which crimson clover was seeded at the last working, the latter part of July. The crimson clover came up well and gave a good covering to the land during the winter and the following spring made a very fine growth and would have cut about two tons of hay per acre. This crimson clover was allowed to mature and the plant began to die, and then (in June) it was plowed under as a preparation for the wheat, to be sown in the fall. The land was harrowed from time to time during the summer to keep it free of grass and after it was gotten into thorough order with harrows and rubber the wheat was seeded October 1st, 1897, at the rate of six pecks per acre. Commercial fertilizer was applied at the rate of 400 pounds per acre, with the drill at the time of seeding the wheat. The fertilizer used was a home mixture composed of:

Dissolved South Carolina rock..........	1,200	pounds
Bone tankage.........................	400	“
Nitrate of Soda........................	100	“
Muriate of Potash....................	300	“
Total	2,000	“

The experiments recorded in this Bulletin were planned by Robert H. Miller, Ex-Director of the Station. and the details were carried out and the records kept under the supervision of Ernest H. Brinkley, Ex-Assistant Agriculturist. Assistant Agriculturist E. O. Garner has aided in the compilation of the results, but for the plan of making the report and the general discussion of the results I am personally responsible.

H. J. PATTERSON, Director.

This mixture cost about twenty dollars per ton and had approximately the following composition:

Phosphoric acid	9	per cent
Nitrogen	2	"
Potash	7½	"

It should be noticed that the nitrogen in this fertilizer was furnished in two forms, viz.: Mineral nitrogen by the nitrate of soda, which is very readily available and serves to give the crop a good start in the fall and have strong healthy plants, which have stooled out well, to go through the winter; and the organic nitrogen which is furnished by the tankage and which becomes available gradually, and this, together with the nitrogen furnished by the decomposing clover will meet the needs of the crop from spring until maturity. This method of nitrogenous fertilization will be found quite essential for all fall grains, and particularly so on land void of organic matter and in a poor state of fertility, as it is necessary to get a good strong plant well stooled out in the fall if a good crop is to be expected. Fall seeded grains stool little, if any, in the spring.

A list of the varieties tested, together with their principal characteristics and yields are given in Table 1.

The promise in the early spring and up to about the middle of May was for exceptionally large yields, but an examination of the yields in the table will show that they average lower than those obtained during the past few years. This is attributed in the most part to the weather turning suddenly, very hot and dry, which caused premature ripening, and in consequence, shrivelled grain. This opinion is also borne out by the fact that as a rule the earlier varieties suffered the least.

The six varieties giving the highest yields were as follows: Lebanon, 35.4 bushels; Currell's Prolific, 35.3 bushels; Dietz, 34.5 bushels; Russell, 32.9 bushels; Pool, 31.8 bushels, and Fultz, 31.8 bushels, which in the main are the varieties which have been doing well for a number of years past.

TABLE I.—YIELD PER ACRE AND CHARACTERISTICS OF VARIETES OF WHEAT TESTED IN 1898. SIZE OF PLOTS, 3412 SQUARE FEET.

Plot No. Varieties.	Yield per Acre. Bushels.	Color of Grain.	Head.	Straw.
1 Ex. Early Oakley	26.6	Amber	Smooth	Stiff
2 Pool	31.8	Red	Smooth	Fairly Stiff
3 Currell's Prolific	35.3	Red	Smooth	Stiff
4 Badger	28.6	Red	Smooth	Stiff
5 Fultz	31.8	Red	Smooth	Stiff
6 Ontario's Wonder	29.5	Red	Smooth	Stiff
7 Rocky Mountain.	27.4	Red	Smooth	Stiff
8 Wyandott Red...	29.1	Red	Smooth	Stiff
9 Finley	29.7	Red	Smooth	Fairly Stiff
10 Fultz	24.4	Red	Smooth	Stiff
11 Wis. Triumph....	27.5	Amber	Smooth	Stiff
12 Garfield	25.9	Red	Smooth	Stiff
13 Terry	27.6	Red	Smooth	Stiff
14 Russell	32.9	Red	Smooth	Stiff
15 Fultz	22.0	Red	Smooth	Stiff
16 Jone's Sq. Head.	19.3	White	Smooth	Stiff
17 Valley	29.0	Red	Bearded	Stiff
18 Ruby	24.7	Red	Bearded	Stiff
19 Dietz	34.5	Red	Bearded	Fairly Stiff
20 Fultz	23.8	Red	Smooth	Stiff
21 Lehigh	26.0	Red	Bearded	Fairly Stiff
22 Lebanon	35.4	Red	Bearded	Weak
23 Tuscan Island ...	26.9	Red	Bearded	Stiff
24 Beal	11.9	Amber	Bearded	Stiff
25 Fultz	25.1	Red	Smooth	Stiff
26 Nigger	30.8	Red	Bearded	Stiff
27 Egyptian	31.5	Red	Bearded	Stiff
28 Gold Coin........	20.8	Amber	Smooth	Stiff
29 Russian	14.6	Red	Bearded	Stiff
30 Fultz	25.3	Red	Smooth	Stiff
Average of six Fultz plots..........	25.4			

On the following pages will be found a list of all the varieties of wheat tested at this Station, up to the present time, classified according to their principal characteristics. There is also given the figures showing the maximum, minimum and average yields obtained with the different varieties. It will be noticed that the minimum yields in most cases are very low. The most of these low yields were obtained in the earlier years of the tests, when the land at this place was in a very run down condition and entirely unfit for the cultivation, not only of wheat, but all classes of crops. Yet, it is interesting to note the changes that can be brought about in a few years, and this, too, by methods within the reach of all Maryland farmers. The land at the Experiment Station ten years ago was unproductive, chiefly because of its physical condition, which was in the main due to being wet and void of organic matter. The first step in producing the proper physical condition was to drain the wet portions by both tiling or open ditches. After this was done the main factors in bringing the land to a satisfactory physical condition for cultivation was to grow green crops, such as cow peas and crimson clover, for turning under, and applying small quantities of lime (20 bushels per acre). In addition to this treatment, the crops were manured with commercial fertilizer, which was particularly rich in phosphoric acid and potash, as will be seen on reference to Wheat bulletins Nos. 10, 14, 28, 35 and 56.

In the tests of varieties new ones were added from time to time and the unpromising ones were discarded, so that comparatively few were grown continuously through any number of years. Of the twenty varieties which were under test over six years, fourteen gave average yields of over thirty bushels per acre, which stand in the following order:

		Bushels.
1	Fultz	36.1
2	Lebanon	35.5
3	Egyptian	34.3
4	Wisconsin Triumph	33.8
5	Tuscan Island	33.5
6	Currell's Prolific	32.6
7	Beal	32.5
8	Badger	31.9
9	Garfield	31.6
10	Dietz	31.4
11	Extra Early Oakley	31.1
12	Jones' Square Head	30.9
13	Finley	32.5
14	Lehigh	30.0

From these results it will appear that the hunt for a superior new variety of wheat for Maryland farmers to adopt as their standard was in a measure fruitless, as the variety which heads our list, and which, under ordinary circumstances, we would recommend to the average Maryland farmer for the crop variety is the stand-by today and was so twenty years ago. While, as the above figures show, there are a number of good varieties of wheat and no doubt that some will be adapted to particular soils and locations, better than the Fultz, yet, none of them are likely to meet the requirements over so great a range of territory and so long a period of time as it has done.

Where Fultz has once done well and now fails to give satisfactory yields, it will generally be found to be due to a deterioration of the seed, either from lack of care in selection or in becoming very much mixed with other varieties. With proper care in observation and selection, it is just as rational and possible to breed up a variety of grain adapted to a particular soil and location as it is to breed up a dairy herd for milk or butter production or hens for egg production. This is a side of farming that is rarely given consideration by a farmer, and yet should be very fruitful of results. Experiments have shown that getting seed wheat from different localities did not give increased yields, but rather with care in selection of seed, that the yield improved with becoming acclimated.

Taking these facts into consideration, the variety tests on the plan pursued in the past will be discontinued and instead experiments will be conducted on selections and breeding up of seed wheats. This work has already been entered upon. Another lesson that may be learned from the work done here is that it is perfectly possible with proper cultivation on lands adapted to growing wheat to make the average yield 30 or more bushels per acre, and seldom, if ever, to fall below 25 bushels. In fact, unless a yield of at least 30 bushels can be obtained, it is doubtful if a farmer is ever justified in growing a crop of wheat, for at present prices, a less yield will cost more than it returns. Even the idea of growing wheat as a necessary step in setting the lands to grass or hay crops, or of growing wheat for the straw for bedding is not a justifiable excuse, as grass can better set when by itself and bedding can be gotten in greater abundance cheaper and of better quality by growing corn and shredding the fodder:

TABLE II.—LIST OF VARIETIES OF WHEAT TESTED AT THE MARYLAND AGRICULTURAL STATION FROM 1889 TO 1899.

	Name of Variety.	No of Years Grown.	Maximum Yield.	Minimum Yield.	Avr'ge Yield.
	White Smooth Wheats:				
1	Golden Amber	3	32.7	7.5	20.5
2	Jones' Square Head	6	40.0	19.3	30.9
3	Miller's Prolific	3	20.9	10.6	15.1
4	New Australian	4	38.9	10.2	24.6
5	White Leader	1	....	....	21.2
6	White Track	2	9.1	7.6	8.4
	White-Bearded Wheats:				
7	Genesee Giant	1	....	....	27.8
	Amber Smooth Wheats:				
8	Extra Early Oakley	7	42.4	17.9	31.2
9	Gold Coin	1	....	....	20.8
10	Imperial Rice	3	26.8	10.1	17.0
11	Martin's Amber	3	35.3	13.2	21.2
12	McCregan	1	....	....	11.8
13	Wisconsin Triumph	6	49.6	11.9	33.8
	Amber-Bearded Wheats:				
14	Beal	7	47.9	14.5	32.5
	Red Smooth Wheats:				
15	American Bronze	1	....	....	7.3
16	Arnold's Hybrid		....	....	17.7
17	Badger	7	46.7	9.3	31.9
18	Buckeye	3	31.8	11.5	22.3
19	Currell's Prolific	8	45.5	13.6	32.6
20	Early Ripe	1	....	....	17.8
21	Finley	8	40.2	12.7	30.8
22	Fultz	7	47.1	22.1	36.1
23	Garfield	7	42.5	10.3	31.6
24	German Emperor	2	32.7	28.2	35.4
25	Golden Drop	1	....	....	8.9
26	Hickman	2	36.6	30.3	33.4
27	High Grade	2	19.3	12.2	15.7
28	Hybridized Fultz	2	12.6	7.2	9.9

	Name of Variety.	No. of Years Grown.	Maximum Yield.	Minimum Yield.	Avr'ge Yield.
29	Jones' Winter Fife..........	1	....	....	10.6
30	McGhee's Red	2	25.1	25.1	25.1
31	Mealey	4	39.9	11.3	23.5
32	New Early Red Clawson....	3	32.1	3.7	14.0
33	New Monarch...............	2	10.0	8.7	9.3
34	Ontario	8	39.7	4.6	26.4
35	Oregon	1	....	....	34.2
36	Pool	7	39.1	9.9	28.0
37	Red Fultz	1	....	....	11.7
38	Red May	1	....	....	19.7
39	Red Russian	3	38.9	9.7	25.2
40	Rochester Red	1	....	....	9.3
41	Rocky Mountain	5	41.8	27.4	33.7
42	Russell	3	38.9	31.8	34.5
43	Strayer's Romania	2	13.9	12.5	13.2
44	Terry	3	37.7	27.6	34.2
45	Winter Fife	2	41.0	31.8	36.4
46	Wyandott Red..............	8	41.0	12.7	29.9
47	Zimmerman	1	....	....	17.2
	Red-Bearded Wheats:				
48	Diehl's Mediterranean	4	32.5	12.0	22.7
49	Dietz	8	42.0	10.5	31.4
50	Dietz Longberry	2	25.9	7.8	16.8
51	Egyptian	6	39.2	28.0	34.3
52	Fulcaster	2	16.5	16.3	16.4
53	Fultz Blue Stem............	2	29.3	29.0	29.2
54	Golden Cross	2	10.4	6.5	8.4
55	Hindoostan	2	3.1	2.9	3.0
56	Hungarian	2	14.5	10.1	12.3
57	Hybrid Dattle	1	....	....	4.6
58	Hybrid Larned	1	....	....	4.2
59	Kentucky Giant	1	....	....	25.0
60	Lebanon	6	42.2	30.2	35.5
61	Lehigh	7	37.0	11.8	30.0
62	Mediterranean	1	....	....	24.9
63	Mediterranean Hybrid	2	8.7	7.6	8.1
64	Miami Valley	2	39.0	32.3	35.6
65	Nigger	8	39.0	6.5	26.4
66	Pegnette's Velvet Chaff.....	2	14.4	11.1	12.7
67	Raub's Black Prolific.......	1	....	....	25.9
68	Red Wabash	2	30.5	29.3	29.9
69	Red Wonder	1	....	....	28.1
70	Reliable	2	8.7	8.2	8.4
71	Ruby	4	41.0	24.7	29.8
72	Russian	1	....	....	14.6
73	Seneca Chief	2	9.4	8.0	8.7
74	Strayer's Egyptian	2	16.3	15.4	15.8
75	Strayer's Longberry	2	12.9	11.7	12.3
76	Tasmania Red	1	....	....	12.8
77	Thesis	2	36.2	25.5	30.8
78	Tuscan Island..............	7	42.4	16.6	33.5
79	Valley	8	42.9	6.7	29.8
80	Velvet Chaff	4	33.8	11.5	20.4

CORN EXPERIMENTS IN 1897 AND 1898.

The experiments made with corn during the seasons of 1897 and 1898 consisted of culture and working tests, and were a continuation of those which were inaugurated in 1893, and upon which reports have been made in Bulletins Nos. 25, 33 and 46. These tests my be classified as follows:

1. Deep vs. Shallow Cultivation.
2. Frequent vs. Unfrequent Cultivation.
3. Wide vs. Narrow Rows.
4. Planting in Drills vs. Checking.

Land used:—The land used for these tests in 1897 had been in early potatoes in 1896, and after digging the potatoes, the land was seeded to crimson clover. The clover took well and made a good growth during the fall which completely covered the ground during the winter. The clover was plowed under the 19th of May, 1897, at which time the heads were beginning to die. The land was thoroughly prepared by means of rubber and harrows and planted to corn May 28th to 31st. All the plots except that for unfrequent cultivation were cultivated three times, June 21st, July 3rd and July 17th. The unfrequent plot received no cultivation on July 3rd.

The land used in 1898 was a sod, from which crops of hay had been cut two years in succession. The sod was plowed down January 20th, which was allowed to lay until April 9th, when it was prepared by means of a "Cutaway" harrow, followed by the rubber and spring toothed harrow. Each test was performed in duplicate on alternate plots, so as to overcome any unevenness in the land.

The corn was planted May 4th, and all the plots were cultivated on May 28th, June 17th and July 11th, except the unfrequent cultivation plot, which received no working on June 11th. All the plots were seeded to crimson clover on July 23rd. Corn was cut on September 13th and husked October 26th to 28th. The spacing of rows and hills and the quantity of corn to each hill was the same as used in these tests in previous years, which was as follows:

On plots of Frequent Cultivation, Unfrequent Cultivation, Deep Cultivation and Shallow Cultivation the rows were 3 feet 9 inches apart and the corn planted 15 inches apart in the row, one grain to each hill. On the checked row plot the hills were 3 feet 9 inches by 3 feet 9 inches and two grains to the hill, while with the drilled corn the rows were 3 feet 9 inches apart and one grain planted every 22½ inches in the row. On the wide row plots the rows were 5 feet apart and one stalk to each 12 inches of the rows, while in the Narrow Rows the distance apart was 3 feet 9 inches and the stalk 15 inches apart in the rows. There was no fertilizer of any kind applied to the land for these tests in 1897 and 1898. In the following tables are given the results of the tests enumerated above, together with those obtained in previous years during which these tests were conducted and averages of the same.

DEEP VERSUS SHALLOW CULTIVATION OF CORN.

TABLE III.—YIELD OF CORN AND FODDER PER ACRE. FOR SIX CONSECUTIVE YEARS.

Years Tested.	Deep Cultivation.				Shallow Cultivation			
	Merchantable Grain. Bus.	Unmerchantable Grain. Bus.	Total Yield of Grain. Bus.	Fodder lbs.	Merchantable Grain. Bus.	Unmerchantable Grain. Bus.	Total Yield. of Grain. Bus.	Fodder lbs.
1893	27.5	11.5	39.0	3040	34.6	10.1	44.7	3212
1894	34.2	5.7	39.9	2755	34.5	6.3	40.8	3325
1895	54.5	1.9	56.4	3241	52.1	1.7	53.8	3125
1896	56.6	2.1	58.7	3050	46.8	2.4	49.2	3226
1897	63.1	3.9	67.0	3540	65.3	3.7	69.0	3068
1898	61.0	3.6	64.6	3909	55.7	3.9	59.6	3764
Average	49.5	4.8	54.2	3256	46.2	4.7	52.2	3286

Note:—All the yields of grain are calculated for 70 lbs. per bushel on the weight of the corn on the ear.

In Deep Cultivation the corn was worked to a depth of six or seven inches, and in Shallow Cultivation only to a depth of two or three inches. The same implement was used in both cases, but was weighted for the deep cultivation.

The results given in the above table show the average to be slightly in favor of the deep cultivation, but the detailed results for the different years divides the favors equally. The rainfall for the growing months, which is given in Table 4, do not contribute anything to explain the reason for these results.

TABLE IV.—RAINFALL FOR THE MONTH IN WHICH CORN WAS GROWING DURING THE SIX YEARS IN WHICH THESE EXPERIMENTS WERE CONDUCTED.

	1893	1894	1895	1896	1897	1898	Average.
May	4.51	3.90	3.16	2.54	7.45	3.49	4.17
June	2.68	1.81	5.50	2.00	3.49	.35	2.63
July	2.74	2.86	2.27	2.23	5.29	2.11	3.08
August ..	1.99	3.56	2.57	1.91	3.02	6.08	3.18
Total	11.92	12.13	13.50	9.68	19.25	12.03	13.06

At the present time there is not so much discussion between Deep and Shallow Cultivation and frequent and unfrequent cultivation as performed in these tests as there is between the old idea to which some people still cling of cultivating corn very deep with the old double shovel plow or a "laying by" with a one-horse plow, in opposition to the method of cultivating corn very frequently all through the season until the ears are well formed with a very light and small rake toothed cultivator, which does not stir the ground more than one-half to one inch deep. This last method, in view of modern studies of root growth and methods for preservation of moisture, should seem to be the most rational to pursue and will form the basis of our future studies upon cultivation.

FREQUENT VERSUS UNFREQUENT CULTIVATION OF CORN.

TABLE V.—YIELD OF CORN AND FODDER PER ACRE FOR SIX CONSECUTIVE YEARS.

Years Tested.	Frequent Cultivation.				Unfrequent Cultivation.			
	Merchantable Grain. Bus.	Unmerchantable Grain. Bus.	Total Yield of Grain. Bus.	Fodder lbs.	Merchantable Grain. Bus.	Unmerchantable Grain. Bus.	Total Yield of Grain. Bus.	Fodder lbs.
1894	33.0	6.5	39.5	3191	35.7	5.4	41.1	2289
1895	47.7	1.6	49.3	3133	52.3	1.5	53.8	3341
1896	44.0	1.8	45.8	2898	43.7	2.3	46.0	2804
1897	66.2	3.6	69.8	3189	56.8	4.1	60.9	2641
1898	61.9	2.3	64.2	3890	60.5	2.8	63.3	3875
Average	50.5	3.2	53.7	3260	49.8	3.2	53.0	2989

In most of these tests the frequent cultivation plot was worked three times and the unfrequent but twice, the middle cultivation being omitted. The same implement was used in both cases. The average results as will be seen gave practically no difference.

PLANTING CORN IN WIDE VERSUS NARROW ROWS.

TABLE VI.—YIELD OF CORN AND FODDER PER ACRE.

Wide rows 5 feet apart, one stalk each; narrow rows 3 feet 9 inches apart, one stalk each 15 inches. For six consecutive years.

Years Tested.	Wide Rows.				Narrow Rows.			
	Merchantable Grain. Bus.	Unmerchantable Grain. Bus.	Total Yield of Grain. Bus.	Fodder lbs.	Merchantable Grain. Bus.	Unmerchantable Grain. Bus.	Total Yield of Grain. Bus.	Fodder lbs.
1893	37.5	9.0	46.5	3786	40.6	10.1	50.7	5443
1894	34.7	4.2	38.9	2280	40.0	5.3	45.3	3485
1895	48.3	1.1	49.4	3006	38.7	1.1	39.8	2588
1896	46.2	2.0	48.2	3370	44.8	1.6	46.4	2851
1897	68.5	1.9	70.4	3514	69.3	2.2	71.5	3607
1898	58.3	1.7	60.0	3362	61.2	2.0	63.2	3862
Average	48.9	3.3	52.2	3219	49.1	2.2	[illegible].8 52.8	3639

The average of the results show that there is practically no difference in the two methods pursued, but a comparison of the results of the narrow rows, where the corn was planted 15 inches apart in the row, and the drilled corn in Table VII., where the corn was planted 22½ inches in the row, show the results on the average to be slightly in favor of the thicker seeding, and in one case, that of 1897, to be as much as 21 bushels in its favor.

DRILLED VERSUS CHECKED CORN PLANTING.

TABLE VII.—YIELD OF CORN AND FODDER PER ACRE.

Drilled corn rows 3 feet 9 inches apart, one stalk each 22½ inches; checked hills 3 feet 9 inches; two stalks per hill. For five consecutive years.

Years Tested.	Drilled Corn.				Checked Corn.			
	Merchantable Grain-	Unmerchantable Grain.	Total Yield of Grain.	Fodder	Merchantable Grain.	Unmerchantable Grain.	Total Yield of Grain.	Fodder
	Bus.	Bus	Bus	lbs.	Bus.	Bus.	Bus	lbs.
1894	59.3	3.5	62.8	3291	55.9	2.8	58.7	3190
1895	34.8	1.0	35.8	2349	32.3	0.9	33.2	1824
1896	48.6	1.2	49.8	2675	41.6	1.2	42.8	1920
1897	47.9	2.5	50.4	1792	47.2	1.9	49.1	2142
1898	53.8	0.8	54.6	2987	52.9	1.2	54.1	2894
Average	48.9	1.8	50.7	2618	46.0	1.6	47.6	2394

The above results show that each year the results were in favor of the drilled corn over checked row planting, and the experience here was that it was just as easy to keep the drilled corn clean.

POTATO EXPERIMENTS—1897 AND 1898.

The tests made with potatoes during the seasons of 1897 and 1898 were a continuation of those which had been in progress for the three previous years and upon which reports were made in Bulletins Nos. 25, 31, 38 and 46. The following is a list of the experiments conducted in 1897 and 1898:

I. Test of Varieties.

II. Spraying for Blight
- 2. Sprayed vs. not Sprayed.
- 3. Early Spraying vs. late Spraying.

III. Culture Tests......
- 4. Early vs. Late Culture.
- 5. Deep vs. Shallow Culture.
- 6. Ridged vs. Flat Culture.
- 7. Wide vs. Narrow Rows.

VARIETY TESTS IN 1897.

Description of Land and Culture:—The land used in 1897 was the plots north of the phosphoric acid series, which was in a heavy, mixed timothy and clover, sod. This was plowed under December 10, 1896, and again gone over with a double shovel plow on April 3, 1897. Commercial fertilizer was applied in the row at the rate of 700 pounds per acre. It was composed of a mixture of 250 pounds South Carolina rock, 200 pounds dried blood, 100 pounds nitrate of soda, and 150 pounds high-grade sulphate of potash. The potatoes were planted April 20 in rows 2 feet 4 inches apart, and one piece dropped each 16 inches in the row. The land was rubbed down May 8 and cultivated May 26, June 12 and June 17. The potatoes were sprayed with Bordeaux solution and paris green on June 7, June 16 and July 7. The yields of the varieties tested in 1897 are given in Table VIII, in which it will be noticed that Holton Rose were used on every sixth row as a check on the inequalities of the ground. The five varieties giving the highest yields in 1897 were as follows: Holton Rose, 263 bushels; Carman No. 3, 252 bushels; Summit, 243 bushels; Carman No. 1, 232 bushels, and Lee's Favorite, 232 bushels.

TABLE VIII.—VARIETIES OF POTATOES TESTED AND YIELDS PER ACRE (1897.)

Plot No.	Name of Varieties.	Merchantable Bushels.	Unmerchantab'e Bushels.	Total Bushels.
1	Early Maine	95.0	25.9	120.9
2	New Bovee	127.4	35.6	164.9
3	Acme Seedling	84.3	19.4	103.7
4	Burr's No. 1 Ford.........	155.6	25.9	181.5
5	Early Harvest	90.7	21.6	112.3
6	Holton Rose	173.9	30.2	204.1
7	Early Cyclone	95.0	25.9	120.9
8	Van Guard	162.0	34.5	196.5
9	Sunlight Star	134.0	30.2	164.2
10	Thorburn	144.6	30.2	174.8
11	Irish Cobler	112.4	19.4	131.8
12	Holton Rose	170.7	30.2	200.9
13	Pearl of Savoy............	159.8	23.6	183.5
14	Charles Downing	127.4	12.9	140.4
15	Lightning Express	178.2	12.9	181.2
16	Early Vaughn	125.2	32.3	157.6
17	Early Ohio	71.8	8.6	80.4
18	Holton Rose	164.1	15.1	179.3
19	Early Puritan	159.8	34.5	194.3
20	Early Northern	155.6	30.2	185.8
21	Beauty of Hebron........	151.1	21.6	172.7
22	Minister	186.8	32.3	219.2
23	Lee's Favorite	201.9	30.2	232.1
24	Holton Rose	184.7	28.7	213.4
25	Early Fortune	140.2	25.9	166.7
26	Early Michigan	166.3	30.2	196.5
27	Early Thoroughbred	71.2	6.4	77.7
28	Milwaukee	144.6	25.9	170.5
29	Early Rose	121.4	25.9	147.3
30	Holton Rose	187.8	17.3	205.1
31	Garfield	199.8	15.1	214.9
32	Carman No. 1............	212.8	19.4	232.2
33	King of Rose.............	169.8	25.9	195.7
34	Salzer's Earliest	60.5	4.3	64.8
35	Drear's Standard	173.9	12.9	186.8
36	Holton Rose	213.9	30.2	244.1
37	Early Wisconsin	168.5	25.9	194.4
38	Arizona	155.6	38.9	194.5
39	Handen Beauty	210.5	21.6	232.1
40	Tonhocks	162.0	43.2	205.2
41	Wisconsin Beauty........	176.0	23.7	199.7
42	Holton Rose	233.4	30.2	263.6
43	Early Market	69.1	10.8	79.9
44	Polaris	114.5	30.2	144.7
45	Early Sunrise	199.8	30.2	230.0
46	New Queen—Home-Grown Seed	178.2	32.3	210.5
47	New Queen—Northern-Grown Seed	199.8	21.6	221.0
48	Holton Rose	178.2	30.2	208.4
49	Summit	204.1	30.2	234.3
50	Lee's Favorite	173.9	36.8	210.6
51	Crown Jewell	195.5	34.5	230.0
52	Carman No. 3............	220.4	32.5	252.9

VARIETY TESTS OF POTATOES, 1898.

Description of Land and Culture:—The piece of land used for this test was the north end of the second section east of the pike and south of the station buildings. It is a clay soil, which had been in sod for two years, and from which two crops of mixed clover and timothy hay had been taken. The sod was plowed under January 20. The ground was prepared April 9 and 10, and potatoes planted on the 11th. They were fertilized in the row at the rate of 700 pounds per acre, of a mixture of 250 pounds South Carolina rock, 100 pounds dried fish, 100 pounds nitrate of soda, and 150 pounds high-grade sulphate of potash. The rows were 2 feet 4 inches apart and the potatoes planted one piece to each 16 inches of row. They were cultivated as usual and sprayed with paris green. The potatoes came up well and made a remarkably fine growth for several weeks and gave excellent promise of a good crop, until the weather turned suddenly dry and hot about the middle of May, when the vines almost entirely died in a few days. The Holton Rose were used on the check plots. The details as to varieties tested and yields obtained are given in Table IX.

The five varieties giving the highest yields in 1898 were as follows: Vigerosa, 134 bushels; Early Vaughn, 132 bushels; Bovee, 131 bushels; Holton Rose, 129 bushels, and Early Harvest, 126 bushels.

TABLE IX.—VARIETIES OF POTATOES TESTED AND YIELDS PER ACRE (1898).

	Varieties.	Primes Bus.	Seconds Bus.	Culls Bus.	Total Bus.
1	Early Michigan	65.0	40.0	18.5	123.5
2	Early Market	57.5	18.3	11.7	87.5
3	Burr's No. 1	60.9	28.3	25.0	114.2
4	Early Harvest	50.8	52.5	23.3	126.6
5	Early Fortune	40.0	53.3	23.3	116.6
6	Arizona	50.8	42.5	30.0	123.3
7	Wisconsin Beauty	50.0	40.8	17.3	122.5
8	Holton Rose	58.3	43.3	27.5	129.1
9	Vigorosa	66.8	39.0	28.3	134.1
10	Signal	50.0	29.2	23.3	102.5
11	New Queen	50.8	47.5	27.5	125.8
12	Early Rose	60.8	40.8	21.7	123.3
13	Polaris	37.7	45.8	27.5	104.0
14	Beauty of Hebron	55.0	28.3	25.0	108.3
15	Triumph	55.0	37.7	20.8	108.3
16	Holton Rose	62.5	28.3	18.3	109.3
17	Ohio Jr.	38.3	35.8	17.3	91.4
18	Early Sunrise	37.7	31.4	23.3	92.4
19	Thorburn	40.0	44.9	28.3	113.2
20	Early Ohio	35.9	18.3	11.7	65.9
21	Acute	38.3	39.0	11.7	89.0
22	Early Vaughn	70.0	44.9	17.3	132.2
23	Heirs Seedling	36.8	31.4	11.7	79.9
24	Holton Rose	59.1	23.3	15.8	112.4
25	Early Northern	59.1	28.3	25.0	112.1
26	King of Earliest	27.5	43.3	18.3	89.1
27	Early Cyclone	28.8	30.0	17.0	78.8
28	Lightning Express	59.1	37.5	21.7	118.3
29	Tonhocks	31.4	55.0	23.3	109.7
30	King of Rose	44.1	31.4	27.5	103.0
31	Lee's Favorite	50.0	25.0	34.0	109.0
32	Holton Rose	58.3	35.8	28.3	122.4
33	Handen Beauty	36.8	37.7	19.2	93.7
34	Crown Jewell	54.0	43.3	17.0	114.3
35	Penn Manor	16.0	27.5	30.0	73.5
36	Maule's Early Thoroughbred	40.0	45.8	23.3	109.1
37	Burpee's Extra Early	53.3	27.5	23.3	104.1
38	Pearl of Savoy	39.0	41.6	17.0	97.6
39	Milwaukee	47.5	24.8	26.6	98.9
40	Holton Rose	36.8	36.8	17.0	90.6
41	Extra Early Vermont	51.7	37.4	17.0	105.1
42	Pride of the South	48.8	24.8	20.8	94.4
43	Pride of the South	45.8	36.8	30.0	112.6
44	Dreer's Standard	60.0	15.8	11.6	87.4
45	Early Puritan	57.5	44.1	21.6	123.2
46	Bovee	43.3	54.0	34.0	131.3
47	Irish Cobler	62.5	40.0	15.0	117.5
48	Holton Rose	44.1	30.0	25.8	99.9
49	Rose No. 25	50.0	37.4	23.3	110.7
50	Early Andes	25.3	32.0	27.0	84.3
51	New Main Crop	36.7	29.0	22.0	87.0
52	Pride of Michigan	23.5	46.9	23.5	93.9
53	Hugh's Seedling	38.0	21.7	19.0	78.7

During the past five years considerable has been done in testing varieties of potatoes, particularly those advertised to be early. Many of them have great claims, made by the originators, which often fail to materialize in actual practice, consequently the farmer should be cautious in spending much on new varieties when they are first introduced. There is a great difference in the value of varieties for different soils and climates, and while the soil at this place is not particularly well adapted to potatoes, yet the results obtained ought to be fairly reliable for most of Maryland.

The following table gives the average results for varieties under test for more than three years and the yield above 150 bushels per acre:

TABLE X.—VARIETIES GIVING AN AVERAGE YIELD OF OVER 150 BUSHELS PER ACRE (1894-1898).

No..	Name of Variety.	No. Years Tested.	Average Yield Bus.
1	Crown Jewell	4	205
2	Holton Rose	3	194
3	Pearl of Savoy	4	174
4	New Queen	5	173
5	Summit	3	170
6	Garfield	3	169
7	Van Guard	3	167
8	Lee's Favorite	3	164
9	Early Rose	4	158
10	Early Harvest	4	156
11	Early Sunrise	3	155
12	Handen Beauty	3	154
13	Arizona	3	153
14	Tonhocks	3	151
15	Early Michigan.	3	150

SPRAYING AND WORKING TESTS IN 1897 AND 1898.

Description of Land and Treatment, 1897:—The land used in these tests in 1897 was the same piece that had been used in the variety potato tests in 1896. After the crop of 1896 was dug, the land was seeded down to crimson clover, which made a remarkably fine growth. This clover was cut for hay on May 17, and the stubble turned under May 31 for the crop of 1897. The potatoes were planted June 21, rubbed down June 28 and cultivated on July 17 and July 31. All plots unless not required by the test, were sprayed on July 20, July 31, August 14 and August 24.

In 1898 these tests were put on a piece of land which had a heavy crop of crimson clover plowed under which had been seeded in the corn crop of 1897 at its last working. The potatoes were planted on July 1 and cultivated on July 12, July 23 and August 22. Early spraying was done on August 1 and 22. Late spraying on August 22 and September 29.

In both 1897 and 1898 the potatoes were fertilized in the row at the rate of 500 pounds per acre of the following mixture: Dissolved South Carolina Rock, 720 pounds; tankage 570 pounds; nitrate of soda 280 pounds; sulphate of potash 430 pounds; total, 2,000 pounds.

The results of these together with those of previous years during which these same tests have been conducted, with the average of the whole, will be found on the following pages.

EARLY VERSUS LATE SPRAYING FOR POTATO BLIGHT.

The experiment was instituted for the purpose of ascertaining how early it is desirable to commence spraying. The early spraying was commenced from ten to fifteen days earlier than the late spraying.

TABLE XI.—YIELD OF POTATOES PER ACRE, EARLY SPRAYED AND LATE SPRAYED.

The average results obtained in these tests show but litttle difference in the two methods.

Years Tested.	Early Sprayed.			Late Sprayed.		
	Merchantable Bus.	Unmerchantable Bus.	Total Bus.	Merchantable Bus.	Unmerchantable Bus.	Total Bus.
1893	.....	.....	90.6	.....	.....	83.9
1894	94.4	28.2	122.6	78.1	19.9	98.0
1895	147.6	14.8	162.4	156.7	17.8	174.5
1896	101.5	8.2	109.7	140.2	3.5	143.7
Average	114.5	17.1	121.3	125.0	13.7	125.0

SPRAYED VERSUS NOT SPRAYED FOR THE PREVENTION OF BLIGHT.

The object of this test was to prevent the leaf blight of the potato which is so prevalent in all sections of this State. The solution used for the purpose was well known Bordeaux mixture, which was made up of six pounds of copper sulphate (Blue stone), six pounds of good, fresh stone lime and fifty gallons of water. The rule was to give three applications to each crop.

TABLE XII.—YIELD OF POTATOES PER ACRE SPRAYED AND NOT SPRAYED.

Years Tested.	Sprayed.			Unsprayed		
	Merchantable Bus.	Unmerchantable Bus.	Total Bus.	Merchantable Bus.	Unmerchantable Bus.	Total Bus.
1893	.....	.....	81.1	.....	.....	61.9
1894	85.9	14.7	100.6	61.9	14.5	76.4
1895	68.8	15.4	84.2	31.7	13.5	45.2
1897	140.0	18.3	158.3	121.1	18.8	139.9
1898	100.2	5.9	106.1	74.2	4.7	78.9
Average	98.7	13.6	106.1	72.2	12.9	80.5

It will be noticed from the above results that there was always a decided advantage in spraying, and one point particularly prominent, that the greatest relative difference occurred in the unfavorable years or when the yeilds were low.

EARLY VERSUS LATE CULTIVATION OF POTATOES.

In this test the plot receiving late cultivation received one more working than the other, which was generally given about ten days after the other had been laid by.

TABLE XIII.—YIELD PER ACRE FROM EARLY AND LATE CULTIVATIONS.

Years Tested.	Early Cultivation.			Late Cultivation.		
	Merchantable. Bus.	Unmerchantable Bus.	Total Bus.	Merchantable Bus	Unmerchantable Bus.	Total Bus.
1894	96.6	18.0	114.6	96.5	20.0	116.5
1895	78.1	13.1	91.2	68.4	13.6	82.0
1896	78.9	15.4	94.3	78.9	11.4	89.3
1897	130.8	16.0	146.8	140.5	19.0	159.5
1898	105.8	9.4	115.2	90.6	7.0	97.6
Average	98.0	14.4	112.4	95.0	14.0	109.0

The average of the results with early and late cultivation give practically no difference in the two methods pursued.

DEEP VERSUS SHALLOW CULTIVATION OF POTATOES.

The implement used in these tests was the same for each plot, but in the shallow cultivation it was set so as not to go more than two to two and one-half inches deep, while in the deep cultivation the cultivation was regulated so as to run five or six inches deep.

TABLE XIV.—YIELD PER ACRE FROM DEEP AND SHALLOW CULTIVATION.

Years Tested.	Deep Cultivation.			Shallow Cultivation.		
	Merchantable Bus.	Unmerchantable Bus.	Total Bus.	Merchantable Bus.	Unmerchantable Bus.	Total Bus.
1894	72.0	18.1	90.1	67.7	20.9	88.6
1895	85.2	15.9	101.1	87.0	15.1	102.1
1896	125.0	12.3	137.3	130.7	9.5	140.2
1897	151.2	17.3	168.5	138.4	14.8	153.2
1898	89.4	10.0	99.4	84.8	6.7	91.5
Average	104.7	14.7	121.1	101.7	13.4	115.1

From the above we see that the average result is slightly in favor of the deep cultivation.

RIDGED VERSUS FLAT CULTURE OF POTATOES.

In this test all the cultivations of both plots were just the same, except the last working of ridge culture, which was given by means of a single shovel plow with broad shovel attached, which threw the earth up in a ridge next to the vines, leaving a hollow in the center of the row. The other plot was cultivated with an ordinary cultivator and left flat at the last working.

TABLE XV.—YIELD PER ACRE FROM RIDGE AND FLAT CULTURE.

Years Tested.	Ridge Culture.			Flat Culture.		
	Merchantable Bus.	Unmerchantable Bus.	Total Bus.	Merchantable Bus.	Unmerchantable Bus.	Total Bus.
1893	71.7	24.1	95.8	72.8	21.3	94.1
1894	77.8	17.9	95.7	69.6	21.7	91.3
1895	64.7	14.6	79.3	73.1	8.7	81.8
1896	92.2	13.9	106.2	85.0	12.3	97.3
1897	144.5	17.8	162.3	154.7	18.3	173.0
1898	77.5	7.0	84.5	93.0	8.2	101.2
Average	88.1	15.9	104.0	91.4	15.1	106.4

From the above table it will be seen that the average results of six years test showed practically no difference between the two methods pursued.

PLANTING POTATOES IN WIDE VERSUS NARROW ROWS.

The wide rows were three feet apart and one piece of potato seed dropped each 12 inches in the row. The narrow rows were used of two widths—2¼ feet apart and 14 inches in the row, and 2¼ feet apart and 16 inches in the row. The latter distance was used in 1897 and 1898. The treatment for both plots was the same in all other respects.

TABLE XVI.—YIELD PER ACRE FROM WIDE AND NARROW ROWS.

Years Tested.	Wide Rows.			Narrow Rows.		
	Merchantable Bus.	Unmerchantable Bus.	Total Bus.	Merchantable Bus.	Unmerchantable Bus.	Total Bus.
1894	67.1	17.9	85.0	86.0	21.0	107.0
1895	67.5	8.9	76.4	79.5	12.8	92.3
1896	63.3	11.3	74.6	89.3	12.9	102.2
1897	143.0	19.0	162.0	150.0	21.5	171.5
1898	91.4	7.0	98.4	70.8	7.8	78.6
Average	86.5	12.8	99.3	95.1	15.2	110.3

The above results show an average difference in favor of the narrow rows. This difference is commonly believed to be due to the greater covering to the ground by the vines in the narrow rows, which causes a preservation of moisture.

PUBLICATION

OF THE

Maryland Agricultural Experiment Station.

These bulletins are sent free of charge to any address upon application to the Director of Experiment Station, College Park, Maryland.

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“	“	12,	March,	1891,	Pig Feeding.
“	“	22,	Sept.,	1893,	Steer Feeding; A Well Balanced vs. A Poorly Balanced Ration.
“	“	24,	Feb.,	1894,	Composition of Commercial Fertilizers sold in this State.
‘	“	26,	June,	1894,	Tobacco.
“	“	29,	Dec.,	1894,	Further Investigations on the Soils of Maryland.
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“	“	32,	April,	1895,	The San Jose Scale.
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“	“	52,	Feb.,	1898,	Composition of Commercial Fertilizers sold in this State.
“	“	53,	March,	1898,	Special Investigation of the So-called “New” Horse Disease in Maryland.
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“	“	55,	May,	1898,	The Black Peach Aphis, Cut Worms in Young Tobacco—Law Providing for the Suppression and Control of Insect Pests and Plant Diseases in Maryland.
“	“	56,	June,	1898,	Wheat, Winter Oats, Barley and Lime Experiments.
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“	“	59,	Jan.,	1899,	Sweet Potato Insects.
“	“	60,	March,	1899,	Some Diseases of the Sweet Potato.
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BULLETIN NO. 63
OF THE
MARYLAND AGRICULTURAL
EXPERIMENT STATION,
COLLEGE PARK, MD.,
December, 1899.

THE
Maryland Agricultural Experiment Station.

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Visitors will be welcomed at all times, and will be given every opportunity to inspect the work of the Station in all of its departments.

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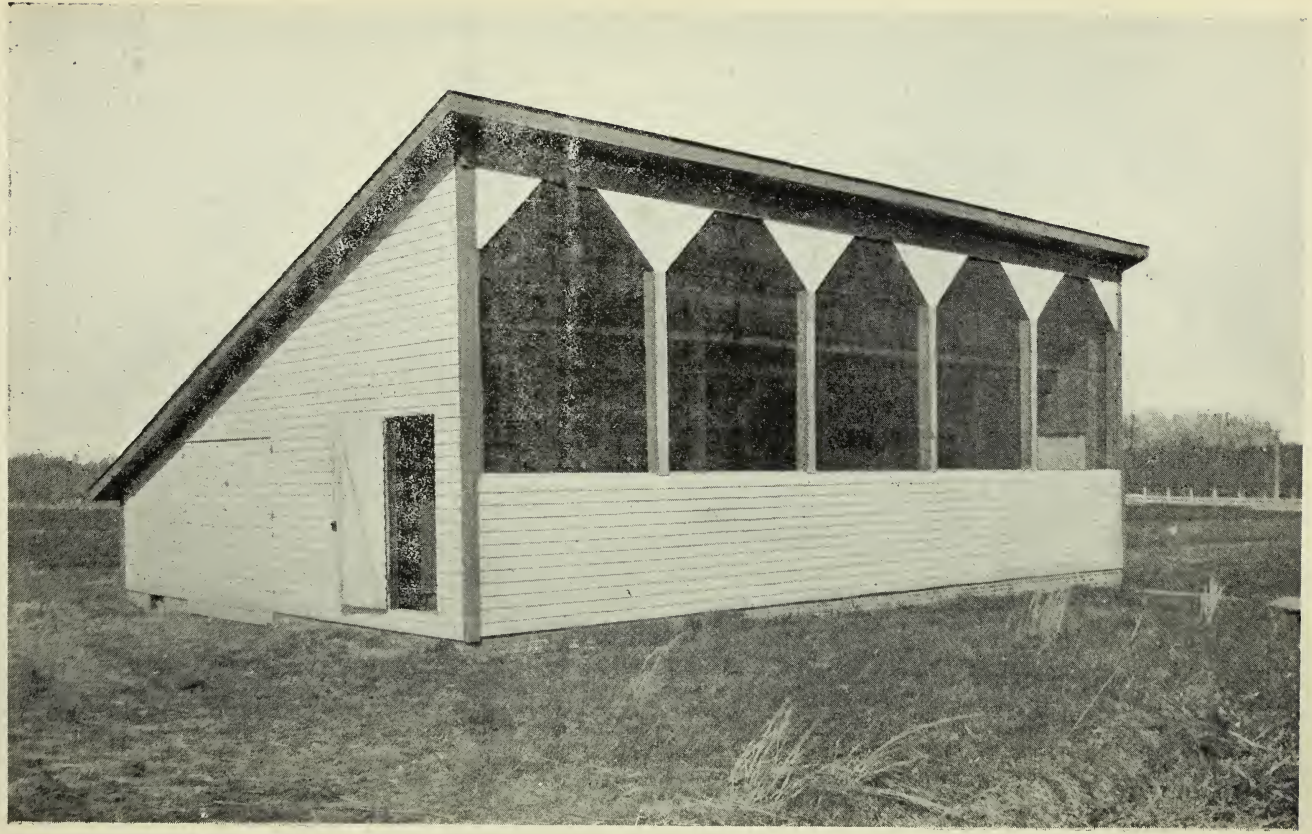


Hog House (Outside front view)

THE MARYLAND
AGRICULTURAL EXPERIMENT STATION.

BULLETIN NO. 63. DECEMBER 1899.

EXPERIMENTS IN FEEDING PIGS FOR THE PRODUCTION OF PORK.

By H. J. Patterson, B. S. Director and Chemist.

GENERAL CONSIDERATIONS.

According to the Eleventh Census of the United States there were 312,000 hogs produced annually in Maryland, of which 186,000 were consumed in the State. These represented a value of about 1,500,000 dollars. The amount produced by the various counties is represented by the following figures:

Allegany	3,576
Anne Arundel	8,817
Baltimore	22,771
Baltimore City	139
Calvert	5,861
Caroline	6,668
Carroll	28,345
Cecil	12,758
Charles	10,524
Dorchester	12,145
Frederick	41,002
Garrett	6,445
Harford	16,466
Howard	10,742
Kent	11,350
Montgomery	17,836
Prince George	10,385
Queen Anne	12,152
St. Mary's	12,540
Somerset	6,425
Talbot	11,011
Washington	26,124
Wicomico	7,277
Worcester	10,661

These figures show that hogs are an important factor in the annual proceeds of the Maryland farm, but, aside from the volume of wealth which they represent, they have such a close relation to the every day sustenance of the farmer, his family and his laborers, as to probably make them occupy a place next to bread in the dietary.. These factors make the production of pork of special interest and make it desirable to know how it may be produced not only economically, but of the very best quality. Again, on most farms and indeed with many families living in small places there are considerable waste products that will go far toward feeding the pigs, so that it is only necessary to make a proper study of supplementary foods in order to make pork contribute materially to the annual income.

Discussions at farmers clubs, institutes, and general inquiry has shown that there is very little definite knowledge as to the cost of production of pork, yet there is a prevalent idea in the minds of those who have thought seriously on the subject that the cost of production is very often more than the market value, and the statement is not infrequently made that most farmers would save money by purchasing the family supplies in the market. Yet here and there a person is found who considers pork one of the profitable products of the farm, and sometimes contends that it can be produced for three cents per pound even though others say eight to twenty-five cents per pound. The quality of the pork is also a point upon which there is considerable variance of opinion, and justly so. This latter point is most always attributed to the methods of curing and cooking, but for all of the reasons the food and feeding of the hog will also have to be taken into account. These facts, together with a desire to utilize waste products, were the reasons which caused the inauguration of the experiments in pork production at this place. The experiments which shall be recorded in this Bulletin are only a few of many which are planned, but give the results so far as determined in three years work. The tests undertaken were such as seemed to be of interest to our people and which the facilities at command made it possible to undertake. Some of the results obtained are fairly conclusive while others will need to be confirmed and supplemented; while still others only give data suggesting future lines of work.

The main aim in all the work has been to test foods within easy reach or methods which could be easily adopted with slight modifications. Again in some of the work it has been the aim to point out means by which the rations commonly used could be modified so as to conform to nature and allow the pig to be fed as nearly as possible as they feed themselves when allowed to run, or in the wild state and not to subject them wholly to artificial methods of feeding as well as living.

HOG HOUSE.

In connection with reporting the results of the feeding experiments which will be found on the following pages it seems to be desirable for many reasons to give some pictures and a description of the hog house which is in use at this place.

Most of the plans for hog houses recorded in literature on this subject refer to those made further north or west where the climate is more severe than in this latitude. This is due no doubt to two causes; first that the hog house of the south has seldom materialized, at least to such a point as to be worthy of being dignified as a house or much less described, for it generally consists of a brushy marsh for summer and a square made of a few old fence rails with some pine brush or corn fodder thrown over the top for winter.

The hog house of the north may suit that latitude but no doubt could be improved upon for that section, and it certainly has many objections for the south; generally the greatest objection being the cost. There is one point that is commonly lost sight of in hog growing and that is that he is an animal to which sun shine is just as essential as it is to the corn plant. Neither corn nor pork can be successfully produced without plenty of sunshine. In the north this sunshine in winter will have to be brought into the pens through glass. In this latitude and further south under normal conditions it is only necessary to face the pen to the south; allow the sun's rays to reach to the back of the pen on the beds and give good shelter and protect from the north and west winds.

The following end elevation and floor plans, together with the pictures, give almost a complete idea of the pen in use here which has met with very general favor. It may, however, be well to enumerate a few of the special points in construction.

1st.—It is faced to the south so as to permit the rays of the sun to shine upon the beds of the pigs at the extreme rear end of the pen in the winter season and also to give shade in that portion in summer.

2nd.—The lattice construction between the pens at the ends and rear admit of a free circulation of air in warm weather.

3rd.—The location of the manure pit in the centre and below the level of the sleeping and feeding floors with all drainage toward it, aids materially in maintaining a proper sanitary condition.

4th.—The ease and facility with which the manure can be removed.

5th.—The swinging gates close the pigs into their beds while the manure is being loaded.

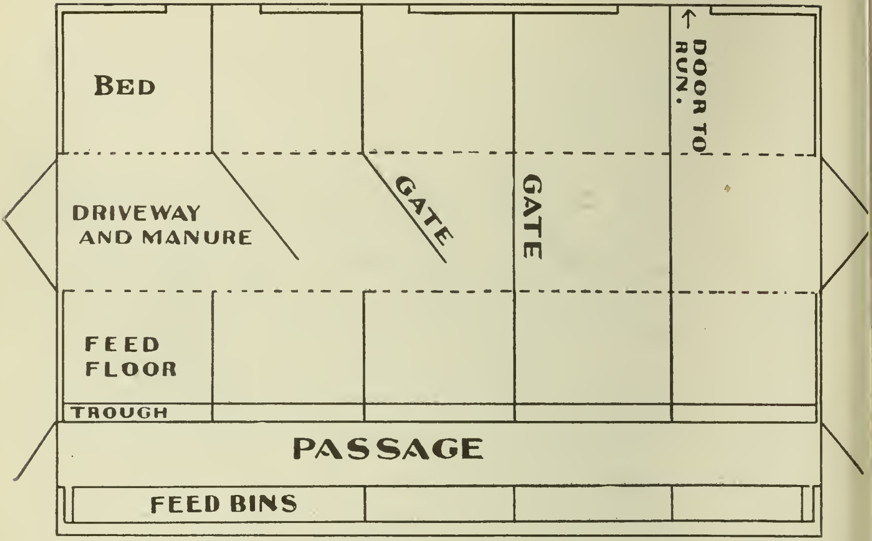
6th.—The swinging fronts to the pens permit the food to be easily placed in the trough and evenly distributed so that the pigs have an equal chance at feeding time.

7th.—The manure pit is concreted which enables the saving of all liquid excrements which with the pig amounts to 51 per cent of the total manure value.

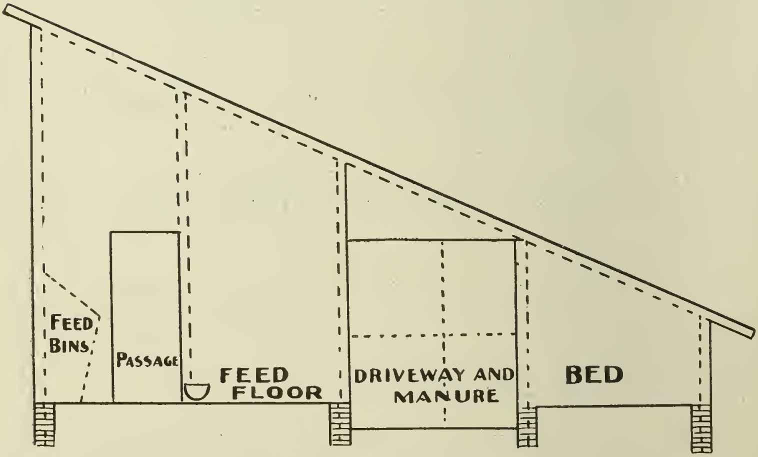
8th.—Ease of changing pigs from pen to pen.

9th.—Feed bins are placed in front of each pen which facilitates feeding and enables keeping different feeds for each pen if desired.

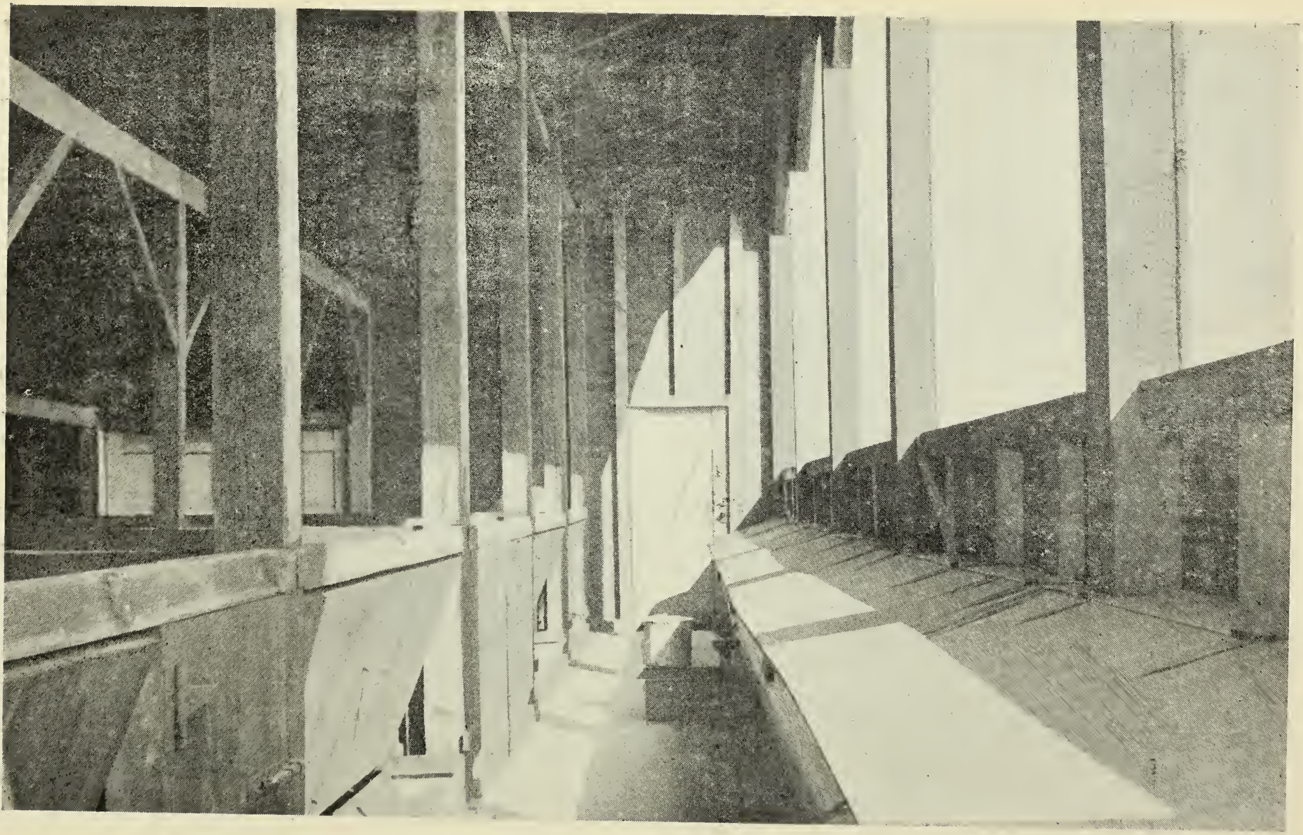
10th.—The general plan can be used and the dimensions and materials modified so as to meet the demand of circumstances.



General floor plan of hog house. Scale, 1-10 inch to 1 foot.



End elevation of hog house. Scale, 1-8 inch to 1 foot.



Hog House—Interior view showing feed bins and feeding alley.

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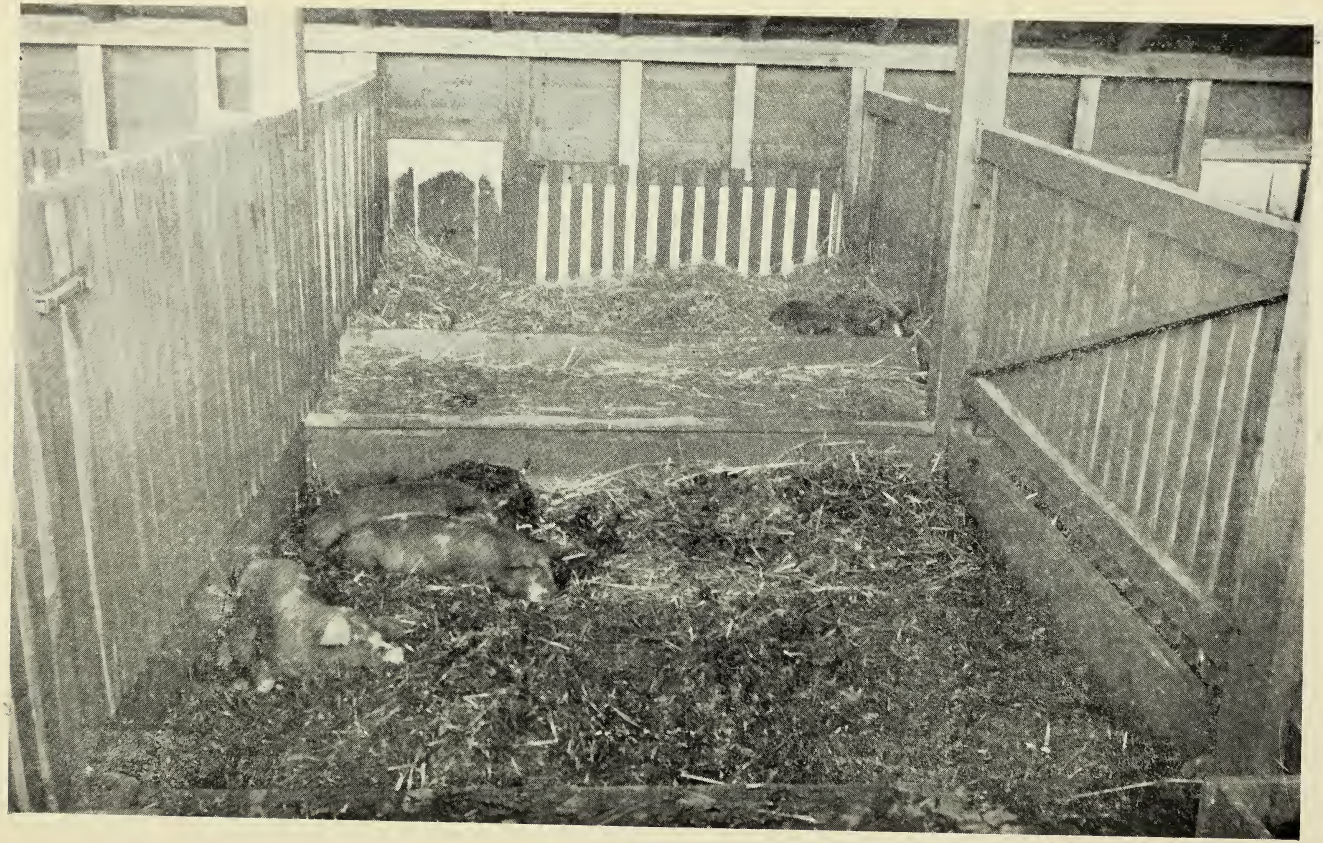

Hog House—Interior view showing bed in rear of pen.

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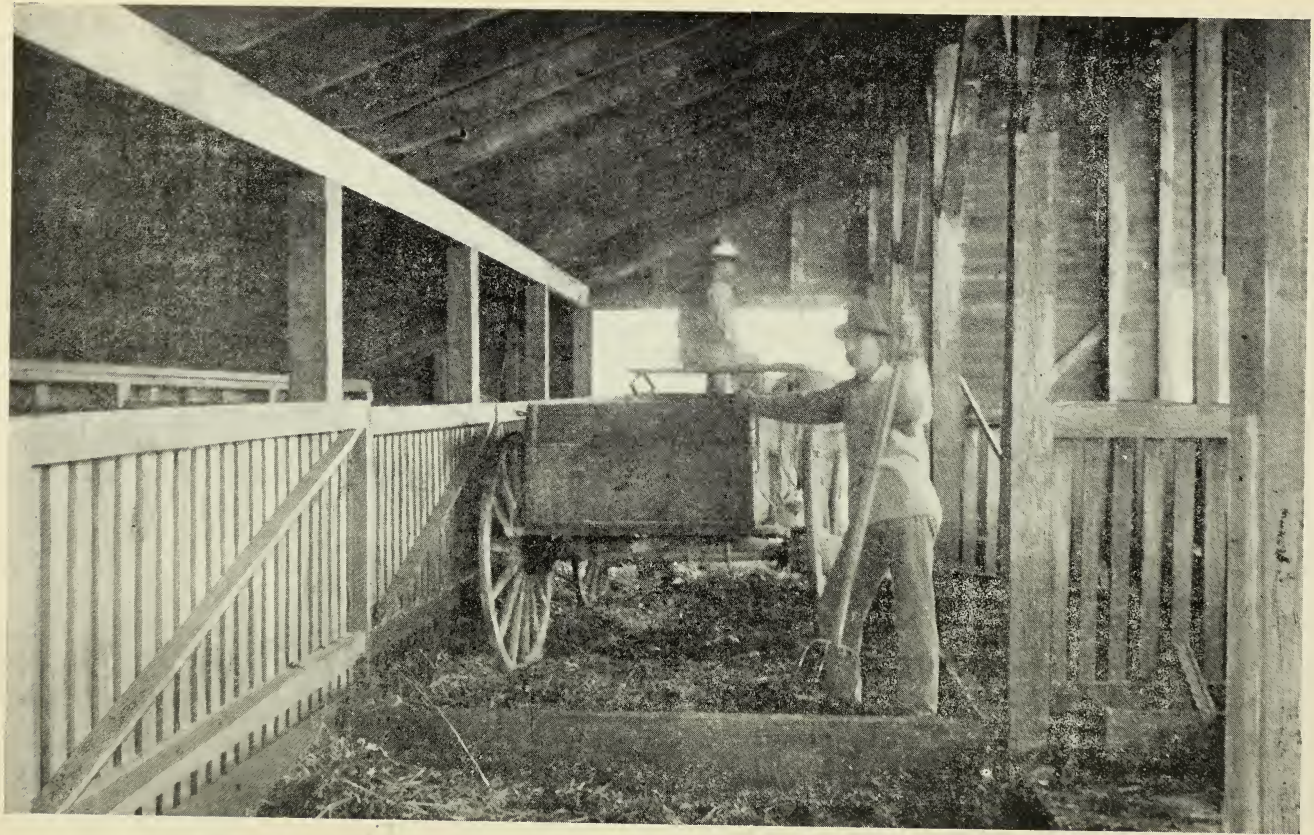

Hog House—Interior view showing method of driving into the pen for the manure.

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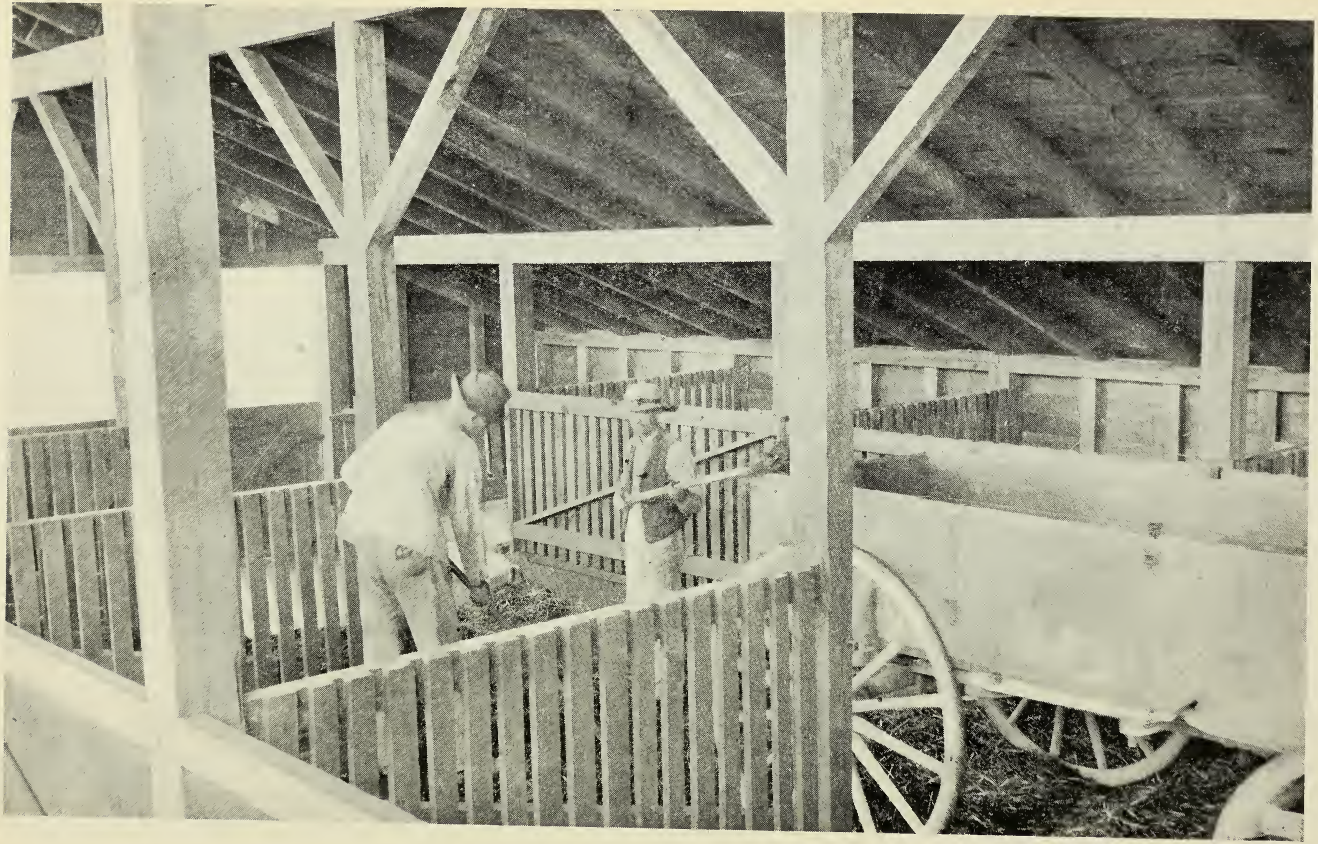

Hog House—Interior view showing wagon in place for loading manure.

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PIG FEEDING EXPERIMENT NO. 1.

A COMPARISON OF THE USE OF SKIM MILK AND GREEN CLOVER AS ADDITIONS TO A RATION FOR PIGS.

The object in this and in all subsequent pig feeding experiments is to determine the most economical means of feeding hogs, considering both the feeds and ages of the pigs, or in other words the aim is to arrive at the most profitable means of producing pork with the feeds and conditions at the command of the Maryland farmers.

It is very common to hear farmers state that their pork costs more than they get for it and no doubt, if strict account were kept, a large percentage of the pork produced by Maryland farmers costs more than it will bring on the market. This is due probably to two causes; the method of feeding and the character and age of the pigs fed.

The pigs used in this experiment were Jersey Red and Berkshire grade crosses and were purchased from W. S. Powell, Esq., of Annapolis Junction, Md. The pigs were at first purchased only with a view of utilizing waste products from the creamery but after they had been here for some time it was decided to use them for making some tests as well.

The pigs were from two litters and were so divided as to give three pigs from each litter in each lot. A crude pen was constructed from such rough lumber as was at hand. This pen was not well adapted to experimental purposes as it gave poor facilities for weighing the pigs frequently and did not afford proper protection from the sun of summer and the cold of winter. An attempt was made to follow the individual pigs by placing in their ears "Dana Ear Tags," but these were soon lost from the most of the pigs and each lot had to be considered as a unit.

The pigs were purchased when they were about eight weeks old and fed all the same until April 27th, when they were put on the rations under test. The preliminary ration consisted mostly of milk and some gluten meal, and wheat bran.

RATIONS USED:—The idea at the time of planning the experiment, was to balance the ration of one lot with separator skim milk and to furnish the other lot with an equivalent amount of protein to be gotten in green clover or other green leguminous crops, according to the season.

To do this would require for each ten pounds of milk fed, approximately 8 pounds of either Red Clover, Crimson Clover, or Alfalfa and 15 pounds of Cow Pea vines. In practice it was found impossible to get the pigs to eat anything like the above proportions, so it was decided that the best thing to do would be to feed the skim milk in about such quantities as would give a balanced ration for the different periods, and to feed the green clover in such quantities as the pigs would consume.

Each lot received the same grain mixture, and the milk or clover, respectively, in addition. The quantity of grain given was guaged according to the demands of the appetites of the pigs.

GRAIN MIXTURE USED.

The following is the grain mixture used, together with the cost of the same at the ruling price of the market for feeds delivered at this point at that time.

TABLE I.

Grain Ration and Cost of Same.

Corn and Cob meal	800	lbs. at	50	cts. per	hundred,	$4.00
Linseed meal	100	“	88	“	“	88
Gluten meal	100	“	67	“	“	67
Total,	1000					$5.55

The amount of digestible food constituents is shown by the following figures:

TABLE II.

Grain Ration and Digestible Matter Furnished by the Same.

Kind of Feed	Quantity in pounds	DIGESTIBLE Protein	N. free extract	Fat	Nutritive ratio
Corn and Cob Meal,	800	35.2	480.0	23.2	1:15.1
Linseed Meal.	100	31.8	32.3	7.1	1: 1.5
Gluten meal,	100	28.7	32.2	15.5	1: 2.3
	1000	95.7	544.5	45.8*	1:6.76
			647.6		

*In the calculation 1 pound of fat is rated as equivalent to 2¼ lbs. of starch or nitrogen free extract.

TABLE III

Composition of Feeds Used.

	Water per cent	Ash per cent	Protein per cent	Crude fibre per cent	N. free exact per cent	Fat per cent
Corn and Cob meal,	15.10	1.50	8.50	6.60	64.80	3.50
Linseed meal,	10.00	4.38	37.36	8.98	31.70	7.60
Gluten meal,	11.41	1.68	34.16	1.76	35.19	15.80
Green Clover,	70.80	2.10	4.40	8.10	13.50	1.10
Separator Skim milk	90.60	0.70	3.20	——	5.40	0.10

The quantity of food consumed by the pigs in the two lots, together with the digestible matter contained therein is shown in tables IV and V.

TABLE IV.

Digestible Nutrients Consumed by Lot A.

	Quantity pounds	DIGESTIBLE Protein pounds	 Carbohydrates pounds
Grain Ration,	4695	449.3	3040.5
Skim milk (Separator)	18312	549.4	1007.2
		998.7	4047.7

Nutritive Ratio of Food Consumed 1:4.

TABLE V.

Digestible Nutrients Consumed by Lot B.

	Quantity pounds	DIGESTIBLE Protein pounds	 Carbohydrates pounds
Grain Ration.	4242	406 0	2747.1
Clover (Green),	864	25.9	128.7
		431.9	2875.8

Nutritive Ratio of Food Consumed 1:6 6.

The weights of the pigs, gains &c. are shown by the following figures :

TABLE VI.

Weights and Gains of Pigs. (Six pigs in each Lot.)

	Lot A	Lot B
Weight April 27, 1896, when pigs were started upon experiment	278 lbs.	283 lbs.
Weight October 8, 1896, end of experiment	1523	879
Total gain in 165 days,	1245	596
Gain per day,	7.55	3.61
Gain per pig,	207.5	99.30
Gain per day per pig,	1.26	.60
Average weight at beginning of experiment,	46.3	47.2
Average weight at end of experiment,	253.8	146.5

Range of weight in Lot A at beginning of experiment,	42 to 59 lbs.
Range of weight in Lot A end of experiment,	209 to 293 lbs.
Range of weight in Lot B at beginning of experiment,	36 to 58 lbs.
Range of weight in Lot B end of experiment,	112 to 190 lbs.

DISCUSSION OF RESULTS OF FEEDING EXPERIMENT NO. 1.

In Lot B, there was 3307.7 lbs. digestible nutrients consumed to make 596 lbs of pork or 5.55 lbs. digestible nutrients to each 1 lb. of pork. The clover furnished 128.7 lbs. of nutrients or the equivalent of 28 lbs. of pork, which deducted from 596 lbs. allows 568 lbs. as produced by 4242 lbs. of the grain ration or 7.47 lbs. of grain to one lb. of pork, which at a cost of

$11.10 per ton for the grain ration made the pork produced by the grain cost $4.15 per Cwt., and the portion attributed to the clover cost $3.09 per Cwt. when green clover is worth $2.00 per ton.

At the above prices for foods, the 596 lbs. of pork resulting from the food consumed by Lot B would cost $24.40 or $4.09 per Cwt. live weight.

Supposing that 4242 lbs. of grain produced 568 lbs. of pork in Lot B, or that it required 7.47 lbs. of grain to produce one lb. of pork, then the 4695 lbs of grain eaten by Lot A should have produced 628 lbs. of pork which would allow 617 lbs. of pork to be credited to the 18312 lbs. of milk consumed or 29.6 lbs. of milk to each one pound of pork. This would give a value of 14 cents per Cwt. for the milk.

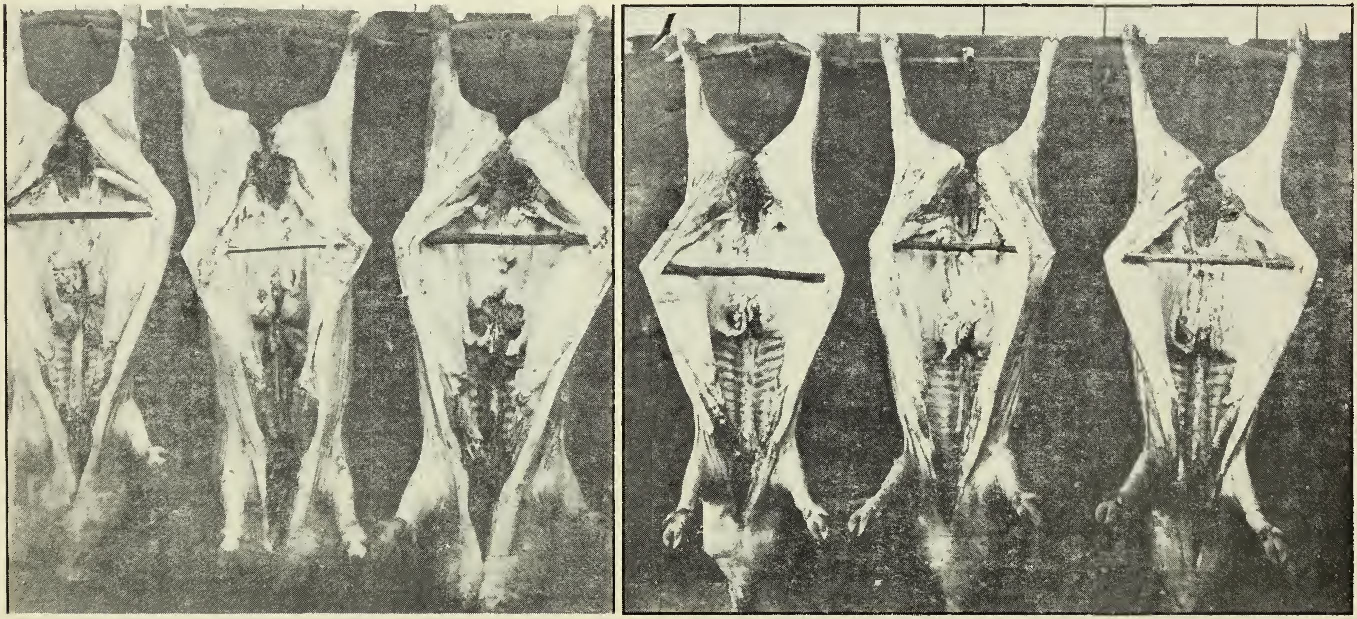
These figures and presumptions of course are not absolutely accurate, for no doubt both the milk and clover had an action in the animal economy of the rations consumed beyond what is represented by the digestible constituents; in fact the mixture of such foods materially contributes toward their digestibility and assimilation. The above results show that separator skim milk is valuable as a hog feed beyond the price ordinarily charged for the product at the creameries. It is not uncommon to find it hard for some creameries to dispose of all their skim milk at one cent per gallon or eleven and one-half cents per Cwt., and the charge at many of the creameries in this state is only ½ cent per gallon. At the price of one cent per gallon and with the gains made by Lot A of 1245 lbs., the cost would be $46.11 or $3.70 per Cwt. for the pork produced.

These pigs, it will be noticed, were 9 or 10 months old at the end of the experiment and that the heaviest weighed over 200 lbs. dressed, which, as will appear from later experiments is too long to keep pigs for the most profit and also as is well known, our markets prefer and pay most for pigs dressing about 150 lbs.

The following picture shows the two pens of pigs, and cross sections of the meat of some of the average pigs from each pen :

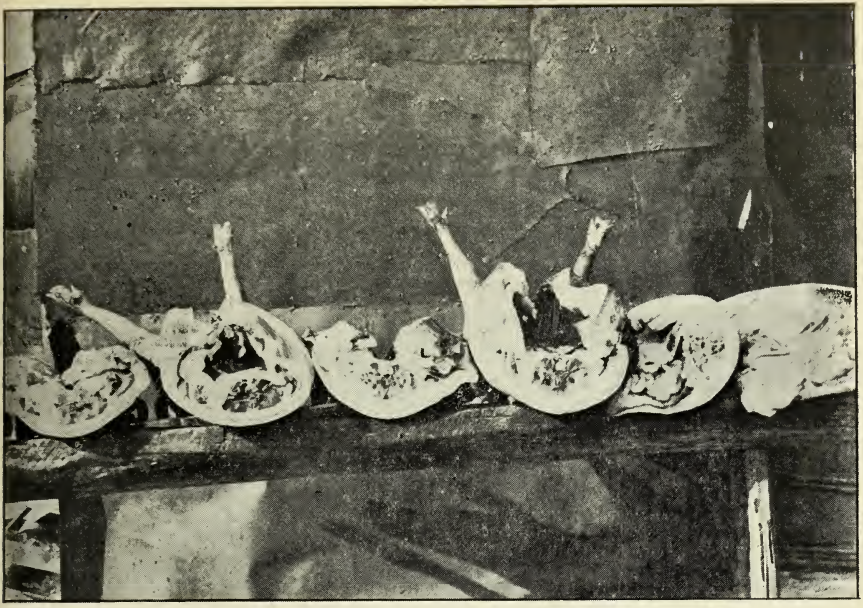
Pigs in Lot A—Picture taken at end of feeding experiment.

Pigs in Lot B—Picture taken at end of feeding experiment.

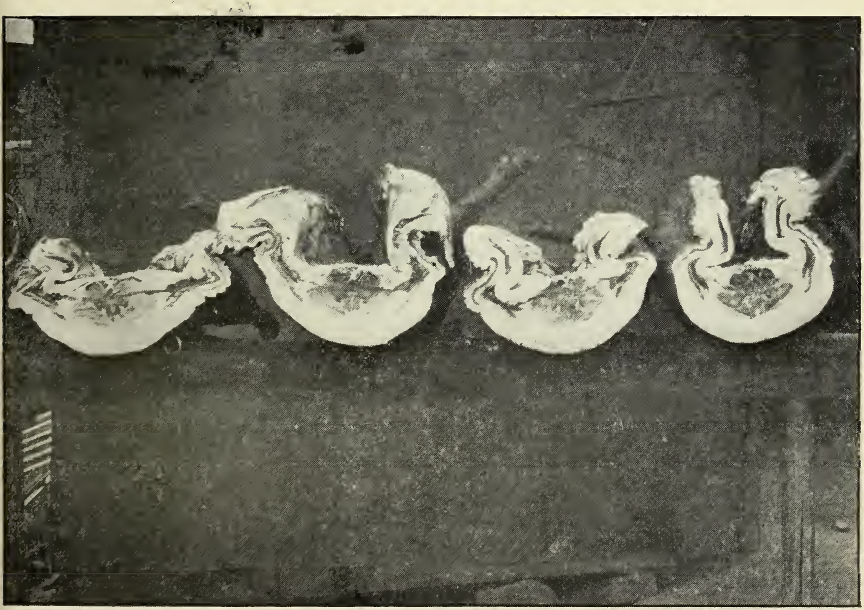


Lot A. Lot B.

Showing the average hogs from each lot after dressing.



Cross section of the meat in Lot B.



Cross section of the meat in Lot A.

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PIG FEEDING EXPERIMENT NO. 2.

A COMPARISON OF THE USE OF SKIM MILK AND GLUTEN AND LINSEED MEALS FOR BALANCING A GRAIN RATION FOR PIGS.

This experiment consisted in balancing a grain ration consisting of a mixture of hominy chop and ground corn fodder (new corn product) for one lot of pigs with separator skim milk and for the other lot of pigs with a mixture of the by products gluten meal and linseed meal.

EXPERIMENT NO. 2.

Lot C—Grain ration balanced with skim milk.

Lot D—Grain ration balanced with gluten and linseed meals.

Duration of experiment—December 1st 1896 to April 1, 1897.

The rations used were made up as follows:

TABLE VII.

Ration fed Pigs in Lot C.

		DIGESTIBLE		
	Quantity.	Protein	Carbohydrates	Fat
Hominy chop,	300	26.7	185.7	18.9
Gr'd fodder (new corn prodt)	100	3.8	49.5	2.3
Separator Skim Milk,	2400	84.0	115.2	2.4
Total.	2800	114.5	350.4	23.6

Nutritive Ratio 1: 3.52.

In practice the grain ration was mixed up in quantity and at the time of feeding, the grain was mixed with milk and water to make a slop. There were approximately six pounds of milk fed for each one pound of the grain during the first two months and then the quantity was gradually reduced until the last month there were only three pounds of milk fed for each pound of grain.

TABLE VIII.

Ration Fed to Pigs in Lot D.

		DIGESTIBLE		
	Quantity Pounds.	Protein Pounds.	Carbohydrates Pounds.	Fat Pounds.
Hominy Chop,	300	26.7	185.7	18.9
Ground Fodder, (N. C. P.)	100	3.8	49.5	2.3
Gluten Meal, (King)	100	33.4	29.8	14.3
Linseed Meal,	200	58.6	65.4	14.0
Total,	700	122.5	330.4	49.5

Nutritive Ratio 1: 3.61.

This grain mixture was used in slop with water for feeding.

The ground fodder shives or the new corn product was introduced with these rations for the purpose of testing the value of coarse fodder in the hog's rations and to see if this particular kind of coarse fodder could be utilized for pigs. It is a well recognized fact, yet one that is very commonly ignored, that a pig's natural instinct is to graze and that it wants coarse matter as well as a grain diet. Those who are most successful at raising pigs and make pork at the least cost almost always graze their pigs or offer some substitute for it; therefore it would seem desirable to mix something with a grain ration as a substitute for the grazing, which is not practicable on many places.

The quantity of food consumed by the two Lots during the different months was as follows:

TABLE IX

Quantity of Food Consumed by Lots C. and D. by Periods.

		LOT C.		LOT D.
	Days	Milk.	Grain Mixture.	Grain Mixture.
December, 1896	31	3162	538	515
January, 1897,	31	3864	784	768
February, 1897,	28	3830	875	878
March, 1897.	31	3392	1168	1169
Total.	121	14248	3365	3330

The pigs used in this experiment were grade Berkshire and were purchased from William Shaw, Colesville, Montgomery county, Md., on October 26, 1896, and were about two months old. They were divided into two lots and fed on a preliminary ration for one month and then the experiment proper commenced December 1, 1896.

TABLE X.

Weights and Gains of Pigs in Lots C. and D., by Months, During Feeding Experiment. (Six Pigs in each Lot.)

			LOT C		LOT D	
		Days	Weight.	Gain	Weight.	Gain.
December	1st		394	......	340	?
January	1st	31	686	292	524	175
February	1st	31	964	278	727	203
March	1st	28	1200	236	945	218
April	1st	31	1514	314	1168	223
Total		121		1120		819

	Lot C	Lot D
Gain per Pig,	186.7	136.5
Gain per day per pig,	1.54	1.12
Average weight of pigs,	252.	195.

Age of pigs at the end of the experiment:—7 months.

DISCUSSION OF RESULTS OF FEEDING EXPERIMENT NO. 2.

In Lot C if we assume that it requires the same amount of milk to produce one pound of pork as was determined by Lot A in Experiment No. 1 or 29.6 pounds of milk to one pound of pork then the 14248 pounds of milk consumed by Lot C should have produced 481 pounds of pork which would have cost $19.95 allowing 14 cents per cwt. for the milk. Deducting the 481 pounds of pork produced by the milk from the total gain of 1120 pounds would give 639 pounds of pork to the credit of the 3365 pounds of grain mixture consumed. Allowing the same valuation for the 639 pounds produced by the grain as for that produced by the milk would make it equivalent to $26.52. Of the 3365 pounds of grain mixture consumed, 2524 pounds were hominy chop. This at the price that was paid for hominy chop had a value of $13.88 and would allow $12.64 as the value of the 841 pounds of ground fodder (new corn product) consumed in the ration. Of course all of these presumptions are not correct but show that such coarse provender as ground fodder (new corn product,) when put in a palatable form, has a value in rations for pigs beyond what is commonly recognized.

If we allow 14 cents per cwt. for separator skim milk; $11.00 per ton (actual cost) for hominy chop, and $11.00 per ton for the ground fodder (new corn product,) the pork produced would cost 3½c per pound; which shows that rations can be compounded so as to produce pork at a profit even when it is selling very low.

In Lot D, if we assume that it requires the same number of pounds of hominy chop and ground fodder to produce one pound of pork, that is 5.27 pounds of a mixture of 3 parts of hominy chop and 1 part ground fodder to produce one pound of pork, then the 1903 pounds of this mixture consumed by lot D would have 361 pounds of pork to its credit. This would leave a balance of 458 pounds of pork as produced by 1427 pounds of a mixture of 2 parts linseed meal and 1 part King gluten meal. Allowing the prices above quoted for hominy chop and the new corn product, and the cost price of the linseed meal to be $16.50 per ton, and gluten meal at $13.50 per ton would make the 819 pounds of gain for Lot D cost $20.52 or $2.51 per cwt. If we should calculate the separator skim milk consumed by Lot C at one cent per gallon, the common price at creameries, then the gain produced by this lot would cost $3.10 per cwt. Even at this price the ration balanced with the by products linseed meal and gluten meal would produce pork over one-half cent per pound cheaper than the ration balanced with skim milk. If same valuation was given for the cost of the pork produced by Lot C as by Lot D the value of the separator skim milk would be 6 cents per cwt. for balancing a ration, as compared to linseed and gluten meals at the above prices.

The following cut shows the average pigs from the two lots dressed.

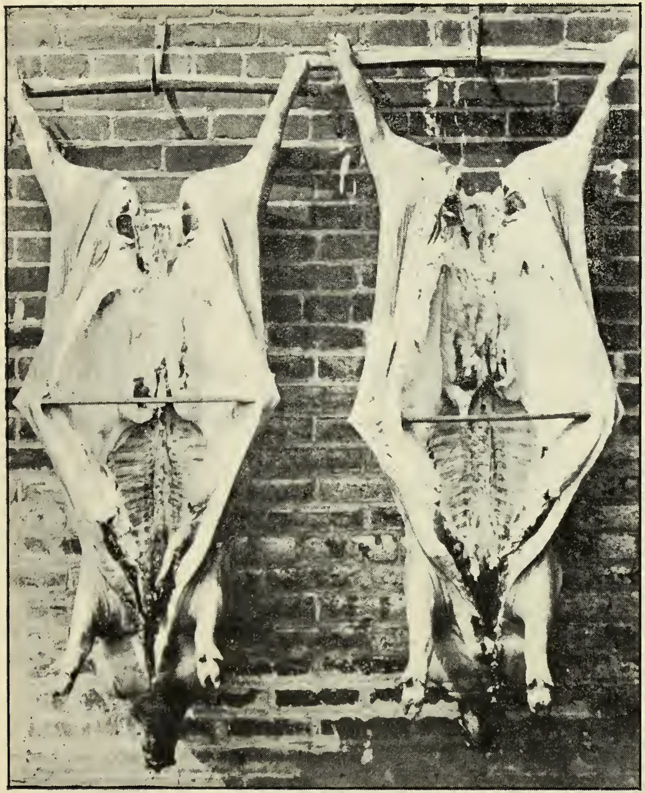
If we calculate the cost of the gain produced during the different feeding periods using the above basis for the cost of the grain feeds and one cent per gallon or eleven cents per cwt. for milk, we have the figures shown in the following table for the cost of one hundred pounds of pork during the different feeding periods.

TABLE XI.

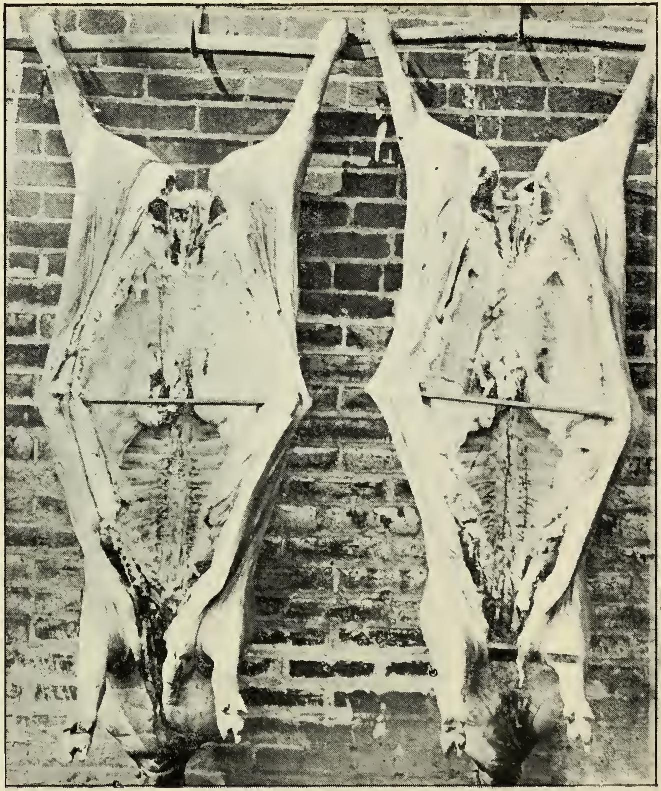
Showing the Food Consumed, Gain in Weight and Cost of Gain per Hundred Pounds, by Periods.

Period.	Month	Days	FOOD CONSUMED		Gain in weight Pounds	Cost of gain per cwt
			Milk Pounds	Grain Pounds		
Lot C.						
1st	December	31	3162	538	292	$2 26
2d	January	31	3864	784	278	3 15
3d	February	28	3830	875	236	3 90
4th	March	31	3392	1168	314	3 29
Lot D.						
1st	December	31	......	515	175	1 90
2d	January	31	......	768	203	2 44
3d	February	28	......	878	218	2 60
4th	March	31	......	1167	223	3 38

It will be noticed from the data previously given that the pigs used in this experiment were sold at about seven months old when the average weight for both lots was 223 pounds, which is heavy enough for market. From the above table we see, with one exception, the older the pigs became the more they ate for a pound of gain and consequently the more it cost to product one hundred pounds of pork. From this the lesson should be learned that it is possible to make marketable pork of pigs but a few months old and that the most profit is made during the earlier months of the life of the pig.



Lot D.



Lot C.

Showing the appearance of two average pigs from each lot after dressing.

PIG FEEDING EXPERIMENT NO. 3.

TESTING THE VALUE OF CORN FODDER AS A FOOD FOR PIGS.

The pigs used in this experiment were purchased in the open market in Washington, D. C., and to all appearances were about two months old and of very nearly the same breeding; but as they grew older and the experiment advanced the pigs showed themselves to be of very different breeding and the indications were that the most of the best bred pigs were in lot F. The pigs were fed a few days on a preliminary ration of chop and milk, and on April 10, divided into two lots as nearly as possible according to weights.

RATIONS USED—The rations used during this experiment were as follows:

TABLE XII.

Ration fed Lot E.

Kind of Feed.	Quantity	DIGESTIBLE Protein	DIGESTIBLE Carbohydrates
Ground fodder (N.C. P.)	200	7.6	109 8
Hominy Chops	500	35.5	397.5
King Gluten Meal	100	32.3	72.5
Linseed Meal	200	58.6	97.0
Skim Milk	2000	70 0	114.0
		205.0	790.8

Nutritive Ratio 1: 3.87.

TABLE XIII.

Ration fed Lot F.

Kind of Feed	Qnantity	DIGESTIBLE Protein	DIGESTIBLE Carbohydrates
Hominy Chop	700	50 0	556
Gluten Meal	100	32 3	73
Linseed Meal	200	28 6	97
Skim Milk	2000	70.0	114
		210.9	840

Nutritive Ratio 1: 3.98.

It will be noticed that the only difference in the ration was the substitution of 200 pounds of hominy chop by 200 pounds of ground fodder (new corn product) in the ration fed lot "E." This gave rations with approximately the same nutrition ratio, but that fed lot E, contained a little less protein and carbohydrates per hundred pounds of feed than that fed Lot F; but they were made as nearly the same in this respect as it was possible to do so. The ground fodder or new corn product was used, as it was the only convenient feed in the proper form which could be obtained.

The aim in feeding was to give, at all times, as much as the pigs could eat clean and with relish but never to over feed or allow feed to stand in the troughs.

TABLE XIV.

Showing the Amount of feed Consumed by Pigs by Periods, and the Quantity required for 100 *pounds of Gain.*

Pigs fed from April 10th to July 10, 1897, (6 Pigs in each lot.)

	LOT E—6 PIGS.		LOT F—6 PIGS.	
	Grain & Fodder	Milk	Grain	Milk
Food Eaten, April 10th to May 10th	512	1024	511	1022
" " May 10th to June 10th	758	1516	753	1506
" " June 10th to July 10th	974	1948	909	1818
Total	2244	4488	2173	4346
Quantity of grain required for 100 lbs of gain during first period.	237	474	216	432
Quantity of grain required for 100 lbs of gain during second period.	286	572	264	528
Quantity of grain required for 100 lbs of gain during third period.	379	758	362	724
Average	304	608	281	562

TABLE XV.

Showing the Quantity of different parts of the Rations Consumed by Pigs in producing 100 *pounds of Gain.*

Quantity required to produce 100 pounds of gain		LOT E.			LOT F.	
		Fodder	Grain	Milk	Grain	Milk
1st period	30 days	47	190	474	216	432
2d period	30 days	57	229	572	264	528
3d period	30 days	76	306	758	362	724
Average		61	243	608	281	562

TABLE XVI.

Showing the Weights and Gains of Pigs by periods.

(Age of pigs at beginning of Experiment—Approximately 2 months.)

	LOT E—6 PIGS.		LOT F—6 PIGS.	
	Weight	Gain	Weight	Gain
Weight April 10th	240		240	......
" May 10th	456	216	477	237
" June 10th	21	265	762	285
" July 10th	970	257	1013	251
Total 90 days		738		773
Average weight of Pigs at beginning of test	40		40	
Average weight of Pigs at end of test	163		169	
Average gain per pig		123		129
Average gain per pig per day		1.37		1.43

TABLE XVII.

Showing the cost of producing 100 *pounds of gain in pigs by periods and the value of ground corn fodder in their rations.*

In prodncing 100 lbs of Gain	LOT E				LOT E		
	Calculated value of fodder	Cost of grain	Cost of milk	Total cost	Cost of grain	Cost of milk	Total cost
1st Period	$0.08	$1.20	$0.55	$1.83	$1.33	$0.50	$1.83
2d "	. 3	1.45	.66	2.24	1.63	.61	2.24
3d "	.25	1.94	.87	3.06	2.23	.83	3.06
Average	.14	1.54	.70	2.38	1.74	.64	2.38

This would give a value for the ground fodder for the first period of $3.40 per ton, for the second period $4.56 per ton and for the third period $6.58, which would seem to indicate that the corn fodder has a greatest value for pigs as they grow older.

It is apparent from the above results that pork can be produced profitably from young pigs and that gains cost more as the pig grows in size and age.

The condition of the pigs made it undesirable to attempt to conduct this test for a longer time during the excessively hot weather which generally occurs during July and August in this lattitude.

PIG FEEDING EXPERIMENT NO 4.

TESTING THE VALUE OF COARSE FODDERS AS FOOD FOR PIGS.

(DECEMBER 1ST 1897 TO FEBRUARY 1ST 1898.)

This experiment was a repetition of No. 3, and was conducted as a check on that test, as there was some doubt as to the lots of pigs being of the same breeding and age as they ought to be for experimental work, and also with the idea of carrying the work on for a longer time in order to test the value of the coarse fodders for older pigs. This part of the experiment was cut short owing to these pigs contracting Hog Cholera from some infested pigs which were placed in the adjoining pen in the same house.

The pigs used in this experiment were purchased from Tarlton B. Stabler of Sandy Spring, Md., and were high grade Poland Chinas. They were brought to the Station on Nov. 5, at which time they were about seven weeks old. They represented two litters and there were six pigs of each litter. They were all fed together until Nov. 30th, when they were divided into two lots as nearly as possible by weight putting the same number from each litter in each lot. The experiment could be conducted with only five pigs to each lot, as one of them became sick.

The rations used in this test were precisely the same as those fed to Lots E and F (see page 22). The weights of the pigs and the food consumed are exhibited by the figures in the following table :

TABLE XVIII.

Total Food Consumed and Quantity Required for 100 lbs. of Gain.

(PIGS WERE ABOUT TWO AND ONE-HALF MONTHS OLD AT BEGINNING OF EXPERIMENT.)

	LOT G, 5 PIGS			LOT H, 5 PIGS	
	Fodder lbs	Grain lbs	Milk lbs	Grain lbs	Milk lbs
Total Food Consumed in Dec.—30 days.	101	405	1012	512	1024
Total Food Con sumed in Jan.—30 days.	129	518	1294	653	1306
Quantity req'd to produce 100 lbs gain :					
1st Period—30 days	45	179	447	185	370
2nd Period—30 days	80	321	803	304	607

TABLE XIX.

Showing Cost of Food Required for 100 *pounds Gain.*

	LOT G.			LOT H.		
Calculated value of fodder	Cost of Grain	Cost of milk	Total Cost	Cost of grain	Cost of milk	Total Cost
00	1 14	51	1 65	1 14	·42	1 56
00	2 04	92	2 96	1 88	69	2 57

TABLE XX.

Weights and Gains of Pigs by Periods. Test No. 4.

	LOT G, 5 PIGS		LOT H, 5 PIGS	
	Weight lbs	Gain lbs	Weight lbs	Gain lbs
Weight December 1st.	307	....	295	....
Weight December 31st,	533	226	571	276
Weight January 30th,	694	161	786	215
Total Gain in 60 days,	....	387	....	491
Average wt of pigs at beginning of test	61	....	59	....
Average wt. of pigs at end of test	139	....	157	....
Average gain per pig	....	87	....	98
Average gain per pig per day	....	1 30	....	1.63

The results obtained in this experiment show that the addition of the fodder in the quantity fed was of no advantage but rather of a slight disadvantage for pigs of the ages used in this test.

All the data of this test confirm that of other tests on the point of the rapid increase of cost in the production of a pound of gain with the advance of age. The results of tests Nos. 3 and 4 indicate that it would be desirable to repeat this line of work and make a test with using different proportions of the coarse fodder and older pigs. This is taken up in Experiment No. 5.

PIG FEEDING EXPERIMENT NO. 5.

TESTING THE VALUE OF DIFFERENT QUALITIES OF COARSE FODDER IN RATIONS FOR PIGS.

This experiment was a repetition of Nos. 3 and 4 with the addition of two lots of pigs to which different amounts of the ground fodder were given in order to get some data as to the proper proportion in which this class of matter should enter into a ration for pigs.

The pigs used in this test were Poland Chinas purchased from Tarlton B. Stabler, of Sandy Spring, Md. At the time of beginning the test they were from 10 to 12 weeks old and the pigs were divided into 4 lots of five pigs each, and so divided as to give the same number (5 pigs) from each litter in each lot, and also so as to give pigs of nearly the same weight to each lot.

RATIONS USED:—The rations used for lots "I" and "J" were the same as used for lots E and F, respectively. Those for lots "K" and "L" contained respectively ¼ and ½ less of the ground fodder. The aim was to feed two pounds of the milk to each one pound of the other part of the ration; but, owing to the scarcity of the milk, it was not possible to give the full allowance after the first month. At the beginning of the second month of the experiment, one pig in lot J fell suddenly sick and had to be cut out of the experiment. The trouble seemed to be rheumatic, the pig being stiff and not able to move about. The amount of food consumed by the several lots is shown in the following table.

TABLE XXI.

Total Food Consumed and Quantity Required for 100 *pounds of Gain.*

(BY PERIODS.)

		LOT I 5 PIGS			LOT J 4 PIGS		
		Fodder	Grain	Milk	Fodder	Grain	Milk
July,	31 days	73	290	713	......	232	457
August,	31 days	97	391	742	......	258	402
September,	30 days	104	419	429	......	403	299
October,	30 days	116	458	426	......	320	277
Total,	122	390	1558	2310		1213	1435
Quantity of milk fed to each pound of grain.				1 2			1 2
Quantity required for each 100 lbs. gain							
1st period		46	182	448	......	176	346
2nd period		62	251	475	......	255	398
3rd period		91	367	376	......	363	269
4th period		116	458	426	......	628	543
Average		74	295	437	......	307	363

Combining the data of Tables XXI and XXV, the cost of one pound of gain is exhibited in the following table :

TABLE XXII.

Cost and Value of Food consumed for one hundred pounds of Gain.

	LOT I				LOT J			
	Calculated value of fodder	Cost of grain	Cost of milk	Total Cost	Cost of fodder	Cost of grain	Cost of milk	Total Cost
1st Period	(–.23)	$1 70	$0 52	$2 22	......	$1 60	$0 39	$1 99
2nd Period	(–.11)	2 35	54	2 89	......	2 32	46	2 78
3d Period	(–.25)	3 43	43	3 86	......	3 30	31	3 61
4th Period	1.55	4 28	49	6 32	......	5 70	62	6 32
Average	(–. 5)	2 76	50	3 26	......	2 79	42	3 21

TABLE XXIII.

Food Consumed and Quantity required for 100 *pounds of Gain.*

(BY PERIODS.)

		LOT K, 5 PIGS			LOT L, 5 PIGS		
		Fodder	Grain	Milk	Fodder	Grain	Milk
July	31 days	55	312	721	38	337	738
August	31 days	75	426	789	50	451	815
September	30 days	75	427	432	54	486	443
October	30 days	78	445	426	58	527	400
Total		283	1610	2368	200	1801	2396
Quantity of milk in lbs. fed to one lb. other feed.				1 25			1 2
Quantity required for 100 lbs. gain							
1st Period		32	180	417	20	179	393
2nd Period		40	230	426	29	267	482
3rd Period		75	427	432	43	389	354
4th Period		104	593	568	62	567	430
Average		53	303	445	35	313	417

From the data contained in table XXIII together with the gains as shown by table XXV the cost per pound of gain is obtained as given in the following table:

TABLE XXIV.

Cost and Value of Food consumed for 100 *pounds of gain.*

	LOT K.				LOT L.			
	Calculated value of fodder	Cost of grain	Cost of milk	Total Cost	Calculated value of fodder	Cost of grain	Cost of milk	Total Cost
1st Period	(–.16)	$1 67	$0 48	$2 15	(–.11)	$1 65	$0 45	$2 10
2nd Period	.16	2 13	49	2 78	(–.23)	2 46	55	3 01
3rd Period	(–.86)	3 97	50	4 47	(– 38)	3 58	41	3 99
4th Period	.17	5 50	65	6 32	.61	5 22	49	6 32
Average	(–.11)	2 81	51	3 32	(–.15)	2 88	48	3 36

TABLE XXV.

Weights and Gains of pigs, by periods. Lots I, J, K and L.

		LOT I, 5 PIGS		LOT J, 4 PIGS		LOT K, 5 PIGS		LOT L, 5 PIGS	
		Wt lbs	Gain lbs	Wt lbs	Gain lbs	Wt lbs	Gain lbs	Wt lbs	Gain lbs
July 1,	31 days	199	....	166	....	204	....	200	....
Aug. 1,	31 days	358	159	298	132	377	173	388	188
Sept. 1,	30 days	514	156	399	101	562	185	557	169
Oct. 1,	30 days	628	114	510	111	661	99	682	125
Oct. 31,	...	727	99	561	51	736	75	775	93
Total gain	122 days	....	528	....	395	....	532	....	575
Average weight of pigs at beginning of test		39.8		41		41		40	
Average weight of pigs end of test		145.4		140		147		155	
Average gain per pig			105 6		99		106		115
Average gain per pig per day			0.87		0.81		0.87		0 94

The results exhibited by the above figures, when taken in connection with those of Experiments Nos. 3 and 4 show the need for more data on many points before definite conclusions could be drawn; but they indicate that the coarse fodders are better adapted to the older and larger pigs and that small pigs should receive smaller proportions of the coarse feed. In Experiment No. 5, all the rations containing fodder proved to be very advantageous after the pigs were six months old.

The experiments, so far, show the best results with coarse fodder when fed in the absence of milk, and this would seem to indicate that these two feeds in some respects supply certain of the same requirements in the animal economy, and that where milk is used there is less requirement for the coarse fodder or supplying some substitute for the grazing portion of the pigs' rations. This indication is also borne out by the facts observed in feeding pigs throughout the whole country, that is that pen pigs receiving milk in addition to other rations, thrive out of proportion to the food contents of the milk.

PIG FEEDING EXPERIMENT NOS. 6 AND 7.

A COMPARISON OF THE USE OF GLUTEN MEAL AND LINSEED MEAL FOR BALANCING HOG RATIONS; BOTH WITH AND WITHOUT THE ADDITION OF COARSE GROUND FODDER.

The pigs used in this Experiment were high grade Poland Chinas, purchased from Tarlton B. Stabler, of Sandy Spring, Md.

They were brought to the Station November 19th, and were all fed alike until December 1st, when they were divided into four lots according to size and also so as to give the same number from each litter in each lot. The pigs represented three different litters and were practically the same age or about eight weeks old when they arrived at the Station. There were eight pigs from litter No. 1; eight pigs from litter No. 2; and four pigs from litter No. 3.

RATIONS USED:—For the first two months of the Experiment Lots "M" and "N" received the same ration, which consisted of a mixture of hominy chop and linseed meal, and Lots "O" and "P" received the same ration which was a mixture of hominy chop and "King" gluten meal. Each lot received one pound of milk to each pound of grain mixture fed.

RATIONS FOR LOTS M and N.

		. . . . DIGESTIBLE	. . . .
	Quantity pounds	Protein pounds	Carbohydrates pounds
Hominy Chop,	600	42.6	477
Linseed Meal,	400	117.2	198
	1000	159.8	675

Nutritive ratio, 1:4.2.
Cost of above mixture $20.00 per ton.

RATIONS FOR LOTS O and P.

		. . . . DIGESTIBLE	. . . .
	Quantity pounds	Protein pounds	Carbohydrates pounds
Hominy Chop,	600	42.6	477
Gluten Meal, (King)	400	114.8	268
	1000	157.4	745

Nutritive Ratio, 1:4.7.
Cost of above mixture, $16.60 per ton.

The cost of the feeds used in the test were as follows:

Hominy Chop,	$16.00	per ton
Gluten Meal,	$16.50	per ton
Linseed Meal,	$26.00	per ton

TABLE XXVI.

Showing the Quantity of Grain and Milk Consumed and Amount Required for 100 *pounds of gain. By periods.*

	LOT M, 5 PIGS		LOT N, 5 PIGS		LOT O, 5 PIGS		LOT P, 5 PIGS	
	Grain	Milk	Grain	Milk	Grain	Milk	Grain	Milk
December	282	282	278	278	255	255	248	248
January	442	442	434	434	308	308	317	317
Total	724	724	712	712	563	563	565	565
Quantity of food required for 100 lbs gain								
December	198	198	238	238	300	300	430	430
January	285	285	245	245	197	197	159	159
Average	242	242	242	242	233	233	220	220

TABLE XXVII.

Showing the cost of producing 100 *pounds of Gain. Linseed Meal vs. Gluten Meal as a Ration.*

Period	LOT M—Linseed			LOT N—Linseed			LOT O—Gluten			LOT P—Gluten		
	Cost of Grain	Cost of Milk	Total Cost	Cost of Grain	Cost of Milk	Total Cost	Cost of Grain	Cost of Milk	Total Cost	Cost of Grain	Cost of Milk	Total Cost
1st	$1 98	$0 23	$2 21	$2 38	$0 27	$2 65	$2 49	$0 34	$2 83	$3 57	$0 49	$4 06
2nd	2 85	33	3 18	2 45	28	2 73	1 63	23	1 86	1 32	18	1 50
Average	2 43	28	2 71	2 42	28	2 70	1 93	27	2 20	1 82	25	2 07

Average Cost of 100 lbs. of Gain by Pigs fed on Linseed Meal Ration $2.70.
Average Cost of 100 lbs. of Gain by Pigs fed on Gluten Meal Ration $2.13.

TABLE XXVIII.

Showing Weights and gains of pigs by periods.

	LOT M, 5 PIGS		LOT N, 5 PIGS		LOT O, 5 PIGS		LOT P, 5 PIGS	
	Wt	Gain	Wt	Gain	Wt	Gain	Wt	Gain
December 1st	187	....	180	....	182	....	185	....
December 31st	330	143	297	117	267	85	241	56
January 31st	485	155	474	177	423	156	441	200
Total	....	298	....	294	....	241	....	256
Average wt. of pigs at beginning	37.4		36.0		36 4		37.0	
Average wt. of pigs at end	97.0		94.8		84 6		88.2	
Average wt. per pig		59.6		58.8		48.2		51.2
Gain per pig per day		0.99		0.98		0 80		0.85

The results obtained above show cheaper gains for the first month with the linseed meal but the average for the two months was in the favor of the gluten meal as far as cost of production is concerned while the linseed meal produced a slightly greater gain.

On February 1st the rations for Lots N and P had 250 pounds of ground fodder substituted for 250 pounds of hominy chop in each ton of the mixture. The same rations were continued for Lots M and O.

The composition of rations N and P are shown in the following table:

TABLE XXIX.

Rations Fed Lot N from February 1st to May 1st, 1899.

		DIGESTIBLE	
	Quantity pounds	Protein pounds	Carbohydrates pounds
Ground Fodder (N. C. P.)	250	9.4	137
Hominy Chop,	950	67.4	755
Linseed Meal,	800	234.4	396
	2000	311.2	1288

Nutritive Ratio, 1:4.1.

Cost of above mixture without the fodder, $18.00.

TABLE XXX.

Ration fed Lot P from February 1st to May 1st, 1899.

		DIGESTIBLE	
	Quantity pounds	Protein pounds	Carbohydrates pounds
Ground Fodder (N. C. P.)	250	9.4	137
Hominy Chop,	950	67.4	755
Gluten Meal ("King")	800	229.6	536
	2000	306.4	1428

Nutritive Ratio, 1:4.6.

Cost of the above mixture without the fodder, $14.60.

In addition to the grain rations, all lots received one pound of Separator skim milk to each pound of the mixture fed.

The pigs receiving the rations to which fodder had been added, ate well and gave no trouble at any time; but the same pigs in those lots receiving the rations without the fodder were, at times, considerably indisposed. The trouble partook of the nature of a rheumatic lameness accompanied by refusing to eat and consequently had to be cut out of the experiment at the times indicated by the following notes: Necessary allowances for feed had to be calculated.

NOTE 1:—On Sept. 18th a pig (barrow) weighing 110 lbs. was cut out of pen M, on account of protruding intestine. This pig was in good health otherwise and ate well at all times.

NOTE 2:—On April 10th a pig weighing 148 lbs. was cut out of pen M on account of lameness and loss of appetite.

NOTE 3:—On April 10th a pig weighing 119 lbs. was cut out of pen O on account of lameness and loss of appetite.

NOTE 4:—On April 22nd a pig weighing 145 lbs. was cut out of pen O on account of lameness and loss of appetite.

It will be noted that all of the pigs having this rheumatic trouble were in those lots receiving the heavy, compact and concentrated rations. This was also true of the pig which was cut out of lot J in experiment No. 5.

TABLE XXXI.

Showing the weights and gains of pigs. Experiments M to R.

	......LOT M.		LOT N, 5 PIGS		.......LOT O......		LOT P, 5 PIGS	
	Weight lbs	Gain lbs	Wt. lbs	Gain lbs	Weight lbs	Gain lbs	Wt. lbs	Gain lbs
	4 pigs				5 pigs			
January 31st	384	....	474	....	423	....	441	....
March 1st	497	113	551	77	561	138	526	85
March 31st	564	67	696	145	746	185	673	147
	3 pigs				3 pigs			
March 31st	410	....	....	....	497	....	....	....
May 1st	470	60	802	106	560	63	790	117
Total gain 90 days		240		328		386		349
Avr. wt. at beginning			95				88	
Average wt. at end			160				158	
Gain per pig				65.6				69.8
Gain per pig per day				0.73				0.77

TABLE XXXII.

Showing the Food Consumed and amount required for 100 *lbs. of Gain.*

	LOT M, Lin'd		...LOT N, Linseed...			LOT O, Glu'n		....LOT P, Gluten...		
	Grain	Milk	Fodder	Grain	Milk	Grain	Milk	Fodder	Grain	Milk
February	380	380	43	304	347	389	389	32	227	259
March	382	382	61	429	490	529	529	55	382	437
April	236	77	74	519	180	297	101	63	440	152
Total	998	839	178	1252	1017	1215	1019	150	1049	848
	Quantity of Food Required for 100 lbs. Gain.									
February	336	336	56	395	451	282	282	38	267	305
March	570	570	42	296	338	286	286	37	260	297
April	393	128	70	490	170	471	160	54	276	130
Average	416	350	54	382	310	315	264	43	301	243

TABLE XXXIII.

Showing the Cost of producing 100 *lbs. gain. By* Periods.

	.........LOT M, Linseed.........			LOT N, Linseed Meal and Fodder...			
	Cost of Grain	Cost of Milk	Total Cost	Estimated value of fodder	Cost of Grain	Cost of Milk	Total Cost
February	$3 36	$0 39	$3 75	(-.32)	$3 55	$0 52	$4 07
March	5 70	65	6 35	3.30	2 66	39	6 35
April	3 93	15	4 08	(-.52)	4 41	19	4 60
Average	4 16	40	4 56	.76	3 44	36	4 56
	.........LOT O, Gluten.........			.... LOT P, Gluten and Fodder.........			
February	2 34	32	2 66	$0 36	1 95	35	2 66
March	2 37	33	2 70	46	1 90	34	2 70
April	3 91	18	4 09	2 20	2 74	15	4 09
Average	2 61	30	2 91	43	2 20	28	2 91

With the Linseed ration the fodder showed an estimated value of $28.00 per ton, and with the Gluten ration an estimated value of $20.00 per ton.

If the fodder is not taken into consideration, the average cost for producing 100 lbs. of gain with the Linseed ration was $4.18 and with the Gluten ration $2.70.

DISCUSSION OF RESULTS OF EXPERIMENTS NOS. 6 AND 7.

The results brought out by the above figures show, that while linseed meal seems to be better adapted to young pigs, such as those used at the beginning of this experiment, yet this was merely a temporary condition, and that by the end of the second feeding period the gluten meal was in the lead both as to the rate of gain and as to the cost of producing the same. At the prices of the feeds at the time of making the tests the gluten meal was by far the more economical, which would also be true for the relative ruling prices of these feeds for the past several years. Anyone can easily make the calculation as to which would be the cheaper in an individual case by substituting the prices in the local markets in the above calculation.

The introduction of the coarse ground fodder (new corn product) in the rations "N" and "P" in this experiment had two noticeable effects; first to materially lessen the amount of the other foods consumed per hundred pounds of gain and so produce it at less cost, or, what is the same thing, give a very good return price for the fodder consumed; second, aside from the economy in the gain produced, the addition of the fodder to the concentrated and compact rations seemed to add materially to the health of the animals and make them endure the higher feeding. This was true in the lots of Pigs (J., N, and P).

This test also conforms to the earlier tests with coarse fodder that it was better adapted to pigs of more advanced age and otherwise more mature, and with such pigs it is really a necessity for the best and most economical results.

From all these tests it would seem to be desirable to mix with hog rations some material as a substitute for grazing when feeding pigs in confinement or if it is not possible to have a material that will mix well with the grain ration,finely cut fodder or other vegetable material may serve equally well as a substitute. Finely cut or ground clover or pea vine hay would possibly be a better coarse feed for pigs than the ground food used in these tests, as they contain more nitrogenous food matter and are also more easily digestible.

PIG FEEDING EXPERIMENTS NOS. 8 TO 12

A COMPARISON OF GRAIN RATIONS WITH PASTURAGE ON COW PEAS; PASTURAGE ON ARTICHOKE; RATIONS OF SWEET POTATO STRINGS.

PIGS OF DIFFERENT AGES USED IN THESE TESTS.

(Duration of Experiment June 1st to December 1st 1899.)

The pigs used in these experiments were 20 Poland Chinas purchased on May 29th from Tarlton B. Stabler of Sandy Spring and 10 Poland Chinas and Chester Whites purchased August 12th from Edward Scott of Holland's Corner.

The Pigs were numbered from one to thirty and marked with the Wilcox Aluminum Ear Tags with the hopes of being able to follow the individual pigs, but this was not entirely satisfactory as some pigs lost their ear tags. The pigs were all about 8 weeks old at the time of purchase.

In the experiments Nos. 8 to 12, the pigs purchased on May 29th were divided on June 30th, into four lots (Q,R,S,T) of five pigs each so as to give the same number from each litter to each lot and also so as to start with the lots of nearly the same weight.

Lot Q was used as a check lot and kept in the pen, a complete record being made of all feed consumed.

The ration fed to lot Q from July 1st to November 1st was made up as follows:

Ground Fodder,	50	pounds.
Wheat Bran,	150	"
Hominy Chop,	200	"
Gluten Meal,	100	"
Total,	500	"

To this was added 20 pounds of milk to each pound of grain fed during July, and from August 1st to October 1st there was fed one pound of milk to each pound of grain mixture. After October 1st there was no milk fed to these pigs.

During July, August and September lot R received the same ration as was fed to lot Q, and lots S and T received the same ration as Q during July and August. These periods gave a test of the individuality of the several lots. The cost of the above ration at the prices paid for the feed which entered into it was 80 cents per hundred pounds and as these results are not for direct comparison with those in tests Nos. 1 to 7, the basis for estimating the cost of the gains will be made on the rate of the actual cost at this time rather than the cost at the time of conducting the earlier tests.

TABLE XXXIV.

Results of Feeding Experiment with Lot Q. showing Gains Produced and Food Consumed and Cost of same. (5 Pigs in Each Lot.)

	Wt. lbs	Gain lbs	FOOD EATEN		FOOD REQ,D FOR 100 lbs GAIN		COST OF 100 POUNDS GAIN		
			Grain	Milk	Grain	Milk	Grain	Milk	Total
June	249	....	....	....	....	....	......	......	......
July	362	113	355	710	314	628	$2.51	$0.70	$3.21
August	466	104	411	411	395	395	3.16	.43	3.59
September	605	139	495	495	356	356	2 85	.39	3.24
October	671	66	668	....	1012	....	8.10	......	8.10
November	793	122	1030*	....	844	....	3 00	.....	3.00
Average weight per pig at beginning	49.8								
Average weight per pig at end	158 6								

*Feed: Corn on tne ear.

The results exhibited in the above table show that for the first three months of feeding the average cost of 100 pounds of gain was $3.32, or that with high priced feeds pork can be produced below the common selling price. The very high cost of the gains produced in October are not reasonable, but are one of those variations that occur and yet cannot be explained in experimenting with animals. This was probably due to some variation in the stomach contents at weighing time from the indications of the gains made during the following month.

The gains made with Lot Q during November, when the feed grain was only ear corn, was very satisfactory and substantiated the general belief and recommendation that the exclusive corn ration is good and economical for the finishing-off period of fattening pigs

TABLE XXXV.

Result of Feeding Experiment with Lot R. Showing the Gains Produced, Food Consumed, and cost of same. 5 Pigs in the Lot.

	Wt lbs	Gain lbs	FOOD EATEN		FOOD REQ'D FOR 100 lbs GAIN		COST OF 100 ....POUNDS GAIN....		
			Grain	Milk	Grain	Milk	Grain	Milk	Total
June	248	....	...	....	....	....	....	....	......
July	332	84	300	600	357	715	$2 85	$0.79	$3.64
August	448	116	341	682	294	588	2 35	.55	2.90
September	593	145	451	902	311	622	2.49	.68	3.17
October	606	13	1380	....	10616	....	....	....	......
November	606	0	1622	...	?	....	....	....	......
Average weight per pig at beginning	49.6								
Average weight per pig at end.	121 2								

TESTING THE VALUE OF SWEET POTATO STRINGS FOR PIGS.

The pigs in Lot R were fed for three months the same grain ration as Lot Q, and a comparison of Tables XXXIV and XXXV shows that the average cost of producing 100 pounds of pork with Lot R was $3.24 and with Lot Q was $3.32.

On October 1st lot R was put on a ration of small sweet potatoes and strings which were fed raw and twice daily in the same manner as the grain ration had been given previously, and all other attention was just the same as before, and the same as given to Lot Q during the balance of the test. An examination of the Table shows that for October it required over five tons of the potatoes to produce 100 pounds of gain, which, if we assume the same influence prevailed in Lot R as existed in Lot Q, would give the potatoes a value of only about $1.60 per ton. Of course this was with an exclusive potato ration and was with rather mature pigs, which should have been better adapted to such a highly carbonaceous ration than younger pigs. But these results showed the sweet potatoes not to be economical or desirable to be fed in this manner, which is a very common way to see them utilized by many farmers.

To test the value of the strings when fed in connection with other feeds and when fed even to younger animals, lot "V" was put on a ration of gluten meal, milk and sweet potatoes during November. The quantities eaten, gains made etc., are shown in Table 39, page 40. When these results obtained are compared with the check lot for these pigs, lot "U" as exhibited in table 38, we find that the 593 pounds of sweet potato strings eaten, in contributing to the 100 pounds of gain, has a value of $2.40 or about 40 cents per hundred pounds of potatoes.

This shows that a combination of feeds supplementing one another so as to obtain a ration more nearly balanced in protein and carbohydrates will give much better results in the gains produced and the feeds consumed are economically used. Thus the sweet potatoes, when given by themselves were nearly worthless, but became valuable when fed with gluten meal and milk.

TABLE XXXVI.

Results of Feeding Experiment with Lot S, showing Gains produced; Food Consumed, and Cost of same. 5 Pigs in the Lot.

	Wt lbs	Gain lbs	FOOD EATEN		FOOD REQ'D FOR 100 lbs GAIN		COST OF 100 ....POUNDS GAIN....		
			Grain	Milk	Grain	Milk	Grain	Milk	Total
June	261	....	....	....	....	....	......	......	......
July	347	86	290	580	337	675	2 70	74	3 44
August	452	105	320	640	305	610	2 44	67	3 11
Sept 1st, 15 days	494	42	210	420	500	1000	4 00	1 10	5 10
Sept. 2nd, 15 days	500	6	?	?	...	....	......	......	......
October	532	32	?	?	....	....	......	......	......
Average wt. of pigs at beginning	52 2								
Average wt. of pigs at end	106 4								

TEST OF THE VALUE OF COW PEA PASTURE FOR PIGS.

With the aim of getting at the value of Cow Peas as a pasture for pigs the old sheep pasture at the south-east portion of the farm, was planted to peas in June but the continued wet weather made the peas late in blooming and in maturing the peas in the pod. It was expected that the peas would be sufficiently matured to turn the pigs upon them by the first of August but they were not ready until September the first, and really not as far advanced as desirable until September the fifteenth. However, to compare the point of turning in upon them early and also later, lot "T" of five pigs were turned in upon the peas September 1st, and lot "S", fifteen days later. The check lots for these were lots "Q" and "R" which were kept in the pen. To test the use of younger pigs in such feeds, the pigs purchased on August 12th were divided into two lots, "U" and "V"; the former fed in the pen and the latter put on the pasture September 15th.

When entering upon the experiment it was hoped to run it for at least two months, but on October 1st there were so few peas left on the vines as to make it undesirable to continue the test after that date.

The pigs on pasture received no attention whatever except to see that they had an abundance of fresh water. The detail of the gains etc., are found in tables 36, 37, and 39. From these tables it will be seen that lot "T" made a gain of 31 pounds for September, against an average of 142 pounds for lots "Q" and "R", which would have a value of about $1.00. Lot "S" only made a gain of 6 pounds in 15 days. This would seem to indicate that the pigs turned upon the peas September 1st had the advantage. An examination and comparison of tables 38 and 39, shows that the younger pigs did much better on the peas than those of lots "S" and "T", and that the five pigs in lot "V" gained 49 pounds in fifteen days or over one-half (.65) pounds per day per pig. This, when all things are taken into consideration, is very satisfactory. The pigs in lots "V" compared very favorably with those in lot "U", as the gains would be 49 pounds as compared with 36 pounds if the gains of both halves of the month were assumed to be equal or if the pigs in lot "U" gained no more than those in lot "V" during the first 15 days of September, then the gains would stand 49 pounds to 52 pounds.

The results with the pigs on peas show them to be well adapted to the pigs which were about three months old when turned upon them. The results with the larger pigs show that pigs which have been highly fed and kept in a pen all their lives are not adapted to turning out where they will have to hustle for themselves if much gain is expected, nevertheless such pigs can maintain themselves and produce small gain. These experiments will be repeated another year with older pigs which have been acustomed to running out and which are not so fat when turned upon the peas.

The pasturing of the pigs upon the peas has a value to the farmer beyond what the pigs get and the gain they produce, in that they work the vines over, tread them down and distribute manure over the field. This puts the vines in a good condition to turn under and they decompose quickly which is particularly advantageous if the field should be desired to seed to wheat or rye. Again, the droppings from the pigs will introduce into the soil desirable ferments which would not be produced if the crop was simply turned under green.

TABLE XXXVII.

Result of Feeding Experiment with Lot T, Showing the gains Produced; Feed Consumed and Cost of same. (*5 Pigs in the Lot.*)

	Wt. ℔s	Gain ℔s	FOOD EATEN		FOOD REQ'D FOR 100 ℔s GAIN		COST OF 100 .....POUNDS GAIN....		
			Grain	Milk	Grain	Milk	Grain	Milk	Total
June	233	....	....	....	....	....	......	......	......
July	352	119	355	710	298	597	$2.38	$0 65	$3.03
August	487	135	405	810	300	600	2.40	.66	3.06
September	518	31	?	?	....	....	......	......	......
October	580	62	?	?	....	....	......	......	......
Average weight of pigs at beginning	46.6								
Average weight of pigs at end	116.								

TESTING THE VALUE OF JERUSALEM ARTICHOKE PASTURAGE FOR PIGS.

The same fifteen pigs which had been on the cow peas in September were transferred to a field of Artichoke during October, and allowed to feed on them at will by rooting them out of the ground themselves.

The Artichoke is a potato-like tuber which grows on the roots of a plant which much resembles sun flowers in appearance and belongs to the sun flower family. They have the following composition, and that of Potatoes is given for comparison.

	Artichoke per cent.	Irish Potatoes per cent.	Sweet Potatoes per cent.
Water,	78.7	78.0	71.8
Ash,	1.1	.9	1.0
Protein,	2.5	2.2	1.5
Crude Fibre,	0.8	18.8	1.3
Nitrogen Free Extract,	16.7		24.0
Fat,	0.2	0.1	0.4

TABLE XXXVIII.

Results of Feeding Experiment with Lot "U," Showing Gains Produced; Food Consumed, and Cost of Same. (*5 Pigs in the Lot.*)

	Wt lbs	Gain lbs	FOOD EATEN		FOOD REQ'D FOR 100 ℔s GAIN		COST OF 100 ....POUNDS GAIN....		
			Grain	Milk	Grain	Milk	Grain	Milk	Total
September 1st	114	....	....	....	....	....	......	...	......
September	185	71	153	282	215	400	$1 72	$0 44	$2 16
October	289	104	265	506	255	486	2 04	53	2 57
November	394	105	388	330	370	314	2 96	35	3 31

The results obtained show that Lot "S' gained about one-fifth of a pound per day per pig; lot "T" gained about two-fifths of a pound per day per pig, and Lot "V" gained about one-fourth of a pound per day per pig. While these are not large gains, yet when it is considered that the crop costs nothing to raise when once planted, (one planting lasting indefinitely) and that the land used is such as could not be used for other crops and that the pigs feed themselves, the gains produced have been economical. No doubt that a little slop or gluten-meal or wheat bran, fed once a day, would have contributed, as with the sweet-potatoes, to a more economical use of the Artichoke and made pork rapidly and very cheaply.

TABLE XXXIX.

Results of Feeding Experiment with Lot "V"; showing Gain Produced, Food Consumed and Cost of Same. (5 Pigs in the Lot.)

	Wgt	Gain	FOOD EATEN		FOOD REQ'D FOR 100 ℔S GAIN		COST OF 100 ....POUNDS GAIN....		
			Grain	Milk	Grain	Milk	Grain	Milk	Total
September 1st	115	....	....	....	....	....	....	....	....
September 15th	134	19	75	150	3.94	788	3.15	.87	4.02
September 30th	183	49	?	?	....	....	....	....	....
October	223	40	?	?	....	....	....	....	....
November	342	119	70	330	.60	277	0 60	.30	3.31
Sweet Potatoes				706	....	593			

SOME OF THE IMPORTANT RESULTS.

1. It was found that with some rations the gains on pigs could be produced as low as $2\frac{1}{2}$ cents per pound.

2. In all the tests where properly compounded rations were used pork was produced at a profit when the pigs were not allowed to become too old.

3. The cost of producing a pound of pork increases with the age of a pig.

4. The aim should be to produce from 150 to 200 pound pigs at six to seven months old for the greatest profit.

5. Skim milk was found to have a feeding value for pigs equal to fully double the price charged at most of the creameries of the State.

6. Separator skim milk at $\frac{1}{2}$ cent per gallon, and linseed and gluten meals at $15.00 per ton, have about the same value for balancing rations for pig feed.

7. Cream or "King" gluten meal was found to be more economical for balancing rations for pigs than linseed meal.

8. Ground fodder, such as the New Corn Product, was found to be a valuable addition to rations for pigs.

9. Sweet potato strings, cow pea pasture and Artichoke pasture, when properly used, produced pork economically..

PUBLICATIONS

OF THE

MARYLAND AGRICULTURAL EXPERIMENT STATION.

These bulletins are sent free of charge to any address upon application to the Director of Experiment Station, College Park, Maryland.

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“	“	6,	Sept.,	1889,	Commercial Fertilizers.
“	“	12,	March,	1891,	Pig Feeding.
“	“	22,	Sept.,	1893,	Steer Feeding; A Well Balanced vs. A Poorly Balanced Ration.
“	“	24,	Feb.,	1894,	Composition of Commercial Fertilizers sold in this State.
“	“	26,	June,	1894,	Tobacco.
“	“	29,	Dec.,	1894,	Further Investigation on the Soils of Maryland
“	“	31,	March,	1895,	Potato Experiments.
“	“	32,	April,	1895,	The San Jose Scale.
“	“	33,	April,	1895,	Horticultural and Agricultural Departments; Small Fruits, Vegetables and Field Corn.
“	“	34,	July,	1895,	Composition of Commercial Fertilizers sold in this State.
“	“	35,	Sept.,	1895,	Wheat, Barley, Oats and Hay Experiments.
“	“	36,	Dec,	1895,	Steer Feeding; A Well Balanced vs. A Poorly Balanced Ration.
“	“	37,	Feb.,	1896,	Composition of Commercial Fertilizers sold in this State.
“	“	38,	March,	1896,	Potato Experiments.
“	“	39,	April,	1896,	Spray Calendar.
“	“	40,	Aug.,	1896,	Composition of Commercial Fertilizers sold in this State.
“	“	41,	Sept.,	1896,	Test of Methods of Preparing and Feeding Corn Fodder
“	“	42,	Oct.,	1896,	The Maryland Trees and Nursery Stock Law and Other Information of Special interest to Nurserymen and Fruit growers.
“	“	43,	Dec.,	1896,	Report upon the Value of a New Corn Product.
“	“	46.	March,	1897,	Corn and Potato Experiments.
“	“	47,	June,	1897,	Dairy Farming.
“	“	48,	June,	1897,	Some Common Injurious Plant Lice with Suggestions for their Destruction.
“	“	49,	Aug.,	1897,	Composition of Commercial Fertilizers sold in this State.
“	“	50,	Sept.,	1897,	Rust and Leopard Spot, Two Dangerous Diseases of Asparagus.
“	“	51,	Dec.,	1897,	Horse-Feeding; Tests of the Digestibility of Oats, Corn, Hay and the New Corn Product.
“	“	52,	Feb.,	1898,	Composition of Commercial Fertilizers sold in this State.
“	“	53,	March,	1898,	Special Investigation of the So-called “New” Horse Disease in Maryland.
“	“	54,	March.	1898,	Tomatoes.
“	“	55,	May,	1898,	The Black peach Aphis, Cut Worms in Young Tobacco—Law Providing for the Suppression and Control of Insect Pests and plant Diseases in Maryland.
“	“	56,	June,	1898,	Wheat, Winter Oats. Barley and Lime Experiments.
“	“	57,	Aug.,	1898,	The San Jose Scale in Maryland.
“	“	58,	Aug.,	1898,	The Hessian Fly and Wheat Diseases.
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THE MARYLAND
AGRICULTURAL EXPERIMENT STATION.

BULLETIN NO. 64. JANUARY 1900.

A STUDY OF THE CAUSE OF MOTTLED BUTTER.

By Chas. F. Doane, B. S., Dairy Bacteriologist and Assistant Dairyman.

One of the most frequent questions asked the butter maker of this Station is for the cause of the uneven coloring often seen in butter. This peculiar spotted appearance is called "Mottles" by Dairymen in general and is characterized by one portion of the butter being much lighter colored than the other. The more deeply colored or highly colored portion appears to a superficial examiner to have absorbed more than a proportional share of the coloring matter while the light streaks seem to have an excess of butter-milk remaining in it as well as to have received too small a share of the coloring. This condition of the butter is not noticeable until the butter has stood a few hours after being worked.

The term "Mottled" can hardly apply to the small white specks often seen in butter and which are caused by small pieces of dry curd. These specks can be kept out by straining the cream just previous to churning through a hair sieve or perforated tin strainer. Mottles is a more deep seated trouble if we are to judge from the number of butter makers who have had difficulty in this way, and is usually supposed to be caused by some mismanagement, either in handling the cream or in the handling of the butter after churning. Those making butter on a small scale and especially during the months of May, June and July are the most likely to have mottled butter as they are not ordinarily supplied with the most improved machinery for handling the butter and the trouble is more likely to occur during these months as any unevenness in the coloring would be noticed only when the butter had enough natural color to distinguish clearly the different shades. Butter makers on a small scale seldom use artificial color. But the butter maker with eight or ten pounds to the churning is not the only one who is troubled with mottled butter, as a part of the butter coming from the larger and sometimes from the best creameries to the city commission men is mottled and that very distinctly. Sometimes the best butter makers have unevenly colored butter and more than one has been forced to give up a creamery on account of this trouble. Perhaps the next buttermaker who took charge would have no trouble whatever and this added to the general mystery surrounding the cause and the cure.

The cause of mottled butter has been and is yet a disputed question and a number of different theories have been advanced by writers and dairymen of more or less ability. The uneven distribution of salt has been given as the cause by much the larger number of modern writers, but many maintain that the use of excessively cold wash-water will cause mottles while the theory of the non-thorough washing of the butter has found a number of supporters. One writer of an old and at one time a standard work on dairying makes the statement that uneven pressure was a potent cause. Fleischman, the great German authority in dairy matters ascribes mottles to defects in the working and salting or in the temperature of working. Grotenfelt in his principles of modern dairy practice, translated by Woll of the Wisconsin Experiment Station says that mottled butter is sometimes caused by a species of bacteria which starting in small patches spread out through the mass giving a pale or faded appearance to the butter wherever the colonies reach.

The author, by practical experiments, has undertaken to sift these various theories to determine the cause or the most common causes of mottles as affecting the butter maker either in the creamery or the ordinary farm dairying. Experimental work was carried out along the line suggested by the theories advanced. The work was all done in the Station creamery where every modern appliance for the care of milk, cream and butter could be utilized. All of the milk used in these experiments was obtained from the Station herd and was secured as free from dirt and filth as practicable. This more than usual care makes the conditions considerably different from those met with in the ordinary creamery where milk comes from a number of sources and in varying conditions. At the same time however it made much more accurate work possible. The evening milk was allowed to stand in the refrigerator over night after being run over a Star cooler, it was then warmed and separated with the morning's milk. From the separator the cream went to the ripening vat, was cooled to 70 degrees fahrenheit and allowed to ripen until it showed .45 per cent. of acid when it was cooled to 50 degrees and was churned the next morning when there was from .55 to .60 per cent of acid. An ordinary box churn was used and the cream was churned at about 50 degrees. The butter was worked on a Mason worker which made six revolutions per minute and this part of the work was always done by the same person so that different lots of butter would receive the same amount of working for the time worked.

THE EFFECT OF COLD WASH WATER.

Aside from the theory that the uneven distribution of the salt is the cause of uneven colored butter the theory held by the greatest number of butter-makers is that excessively cold wash-water or the free and injudicious use of ice in the churn is the cause of mottles. Different reasons why the cold wash-water should have this undesirable effect on the butter have been advanced. One is that the excessive cold effects only the outside of the granules, as fat is a poor conductor of heat, and the inside is not influenced by the cold. This is supposed to give a different shade to the two portions. Another reason given is that the cold prevents the salt from penetrating the granules because of the chilling of the outer portion.

To test the influence of the temperature of the wash-water the butter from each of five churnings was divided into two lots immediately after the butter-milk was drawn. One lot from each churning was washed with water at 52 degrees temperature, the temperature of churning. This is the temperature usually advised by authorities on butter making, and it certainly could have no evil effect as it would have no influence on the temperature of the butter granules. The other lot from each churning was washed with water from 35 to 40 degrees which will be found to be about the temperature of what is ordinarily termed ice-water.

It is obvious that the butter granules in an experiment of this kind must be larger than is usually advised or the light and more deeply colored portions of butter would be so small as to be unnoticeable. In this experiment the butter was churned until the granules were about three times the size of grains of wheat or about the size of peas. The granules run very unevenly in size and shape and will always be found to be the case in butter from cream churned at 50 degrees.

The cold wash-water was allowed to remain in the butter about one minute,which is about the average time in ordinary practice as it would take a minute for it to run from the churn if drawn immediately. But a few trials were made in which the water was allowed to remain in the churn until there could be no question but that the butter granules had been chilled throughout.

The result of these trials can be seen from the following table:

TABLE I.

No. of churning	Temperature of wash water.	Time in wash water.	Time worked	Appearance after working.
1st	50	one min.	3 min.	Evenly colored.
1st.	50	“	4 min.	Evenly colored
1st.	35	“	3 min.	Slightly mottled.
1st.	35	“	4 min	Evenly colored.
2nd.	50	“	3 min.	Slightly mottled.
2nd.	50	“	4 min.	Evenly colored.
2nd.	35	“	3 min.	Slightly mottled.
2nd.	35	“	4 min.	Evenly colored.
3rd.	50	“	3 min.	Evenly colored.
3rd.	50	“	4 min.	Evenly colored
3rd.	40	“	3 min	Slightly mottled.
3rd	40	“	4 min.	Evenly colored.
4th	50	“	3 min	Slightly mottled.
4th.	50	“	4 min.	Evenly colored
4th.	40	“	3 min	Distinctly mottled
4th.	40	“	4 min.	Evenly colored
5th.	50	“	3 min.	Evenly colored.
5th.	50	“	4 min.	Evenly colored.
5th.	40	“	3 min.	Evenly colored.
5th.	40	“	4 min.	Evenly colored.
6th.				
6th.	40	15	3 min.	Slightly mottled.
6th.	40	“	4 min.	Evenly colored.
7th.	40	“	3 min.	Evenly colored
7th	40	“	4 min.	Evenly colored
8th.	40	“	3 min.	Slightly mottled.
8th.	40	“	4 min.	Evenly colored.
9th.	40	“	3 min.	Evenly colored.
9th.	40	“	4 min.	Evenly colored.

It will be seen from table No. 1 that out of the five lots of butter washed with water at 50 degrees for one minute and worked three minutes, but one lot was mottled and that very indistinctly so. Out of five lots washed with excessively cold water for one minute and worked three minutes, four were mottled, one of them being very distinctly so. Not any of the butter worked four minutes was mottled. Out of the butter washed with the cold water for fifteen minutes and worked three minutes, two lots were slightly mottled. None of the same butter was mottled when worked four minutes. In every case of uneven coloring excepting the one where the streaks were the most distinct the trouble appeared to have come from the individual grains as the spots were round and very small. However it was found, after a number of trials, that any butter which is badly mottled if put on the worker and worked just the right length of time will have the same characteristic appearance as the mottled butter resulting from experiments noted in Table No. 1. The butter looks streaked rather than otherwise at first. As the working progresses and the butter is turned ovor and over the large streaks naturally become smaller and also become rounded in form, until just on the border land between mottled and perfectly colored butter the spots are very small, appear to be round and are rather indistinct. The reason why butter washed with excessively cold water is more likely to be mottled can be explained on more satisfactory grounds than is usually advanced. Butter so washed is of course much harder than when washed with water at 50 degrees. When it is put on the worker it will be found to be much more difficult to handle. And it will often require three or four revolutions of the worker before the granules become firmly enough matted together to allow being turned with a ladle. Even after this stage is reached the butter is so hard and so difficult to turn with the ladle that it is almost impossible to give it the same amount of working with the same number of revolutions of the worker that the softer butter would receive. The difference in the working of the soft and hard butter was very noticeable even where the amount of butter was limited and where a small worker was used as was the case at this Station during these experiments. In a large creamery where the butter from 2000 pounds of milk would be put on the worker at one time the difference would be much greater. It is very easy to conceive under these conditions how a butter-maker, who had been in the habit of washing the butter in water at the temperature of churning and suddenly changed to colder water, would have mottled butter. The mottles would resemble small round pellets and the butter-maker would naturally conclude that the action of the excessively cold water on the separate granules was the cause of his trouble. He would fail to consider that the butter had not received sufficient working because it was harder than the butter which he had been in the habit of handling.

With a combined churn and worker, such as is coming into general use in many of the larger creameries, the difference in the length of time required to work soft and hard butter is greater than with the Mason worker. The rollers in the combined churn are so far apart that when the butter is washed with water as low as 35 degrees it will require several minutes of working before the granules will be formed into a compact mass and the actual working can begin.

The butter which was allowed to remain in the cold water for fifteen minutes behaved practically the same as where it was allowed to remain for only one minute. It could not even be noticed that it was any harder, which would go to show that even with one minute washing the granules must have been chilled through.

It is well to call attention to the fact that though many of the lots were mottled when worked three minutes none were mottled after working four minutes. This fact would seem to suggest that it is possible, in some cases at least, to work the mottles out of butter. Attention will be called to this again.

EXPERIMENTS WITH SALTING.

As has been mentioned before the theory for the cause of mottled butter which has found the greater number of supporters is that having the salt unevenly distributed through out the mass of the butter will cause it to be unevenly colored. To test this theory the butter from each of twenty churnings was divided into two lots after washing. One lot from each churning was worked one minute without salting, and set in the refrigerator. The other lot from each churning was salted, worked one minute and then set in the refrigerator. Not one of the unsalted lots was at all mottled while in every case the salted lots were very distinctly mottled. Furthermore by simply tasting the light and more deeply colored portions of the butter it could be easily distinguished that the former had very little, if any, salt and the latter had enough and to spare. So marked was this difference in the taste that no chemical analysis was necessary to demonstrate that one portion had much more salt than the other. Since performing these experiments the author has had access to a large number of samples of butter which have been marked down in price by commission men because of being mottled. In every case where the unevenness in the coloring was very distinct it was entirely possible to distinguish by the taste that the light streaks either had no salt or less salt than the more deeply colored portions. So many samples of mottled butter have been examined and the experiments at this Station were so marked and uniform in their results that it does not leave much room for doubt that considerable, if not the greater part of the uneven colored butter, is so because the salt has not been thoroughly worked in.

It was noted in the experiments where a part of the butter was salted and a part was worked without salt that the latter was always much lighter in color than the former after the salted lots had received the necessary amount of working to evenly distribute the salt and make it even in color. To demonstrate this point with butter which had been treated the same in every way except in the salting, each of five churnings of butter was divided into two lots. One lot from each churning was worked twenty revolutions of the worker without being salted. The other lots were salted and worked the same number of revolutions, which was sufficient to thoroughly distribute the salt. One pound prints were made from each of the churnings, half of the pound being of unsalted and the other half of salted butter. The difference in coloring could be distinguished slightly immediately after working and printing. At the end of twenty-four hours this difference was very marked. These prints of salted and unsalted butter were in reality mottled butter, as the difference in the shade of the coloring of the two portions came from the same cause as the patches or streaks of light and dark seen in tubs of mottled butter.

HOW THE SALT CAUSES MOTTLES.

Having the salt unevenly distributed through the butter causes it to be unevenly colored is certain in many cases. It is also certain that it does this by giving the salted portion a more pronounced yellow color. Why the salt has this effect has not been satisfactorily explained. It has been suggested that it is because the salt drives out the butter-milk along with the excess of water in the butter, and the fact that the unsalted portions of the butter appear to have an excess of butter-milk would suggest that this might possibly be a good explanation. To test this the samples of butter before alluded to where one lot from each of five churnings was salted and the other lot from the same churning was unsalted were submitted to a chemical analysis to determine the per cent. of curd.

The following table shows the result of the analysis :

TABLE II.

Lot.	Casein per cent.
a1	.33
a2	.32
b1	.24
b2	.23
c1	.26
c2	.39
d1	.59
d2	.34
e1	.46
e2	1.8

In the table where the two lots are given as a1 and a2 the same letter represents the same churning. All of the numbers 1 were unsalted and the numbers 2 were salted. Thus a1 and a2 are two lots from the same churning; a1 was unsalted and a2 was salted.

From three of the churnings the salted lots had less Casein than the unsalted. In the case of d1 and d2 the difference was very marked. In the other two churnings, however, the salted lots had more Casein than the unsalted. In all of these churnings the unsalted lots were much lighter in color than the salted. In the churnings where a larger percentage of Casein was found in the salted than the unsalted the difference in the shades of color was just as marked as where the larger percentage of Casein was found in the unsalted lots. It is evident this being the case, that mottles is not caused by any excess of Casein in the unsalted portions.

To test farther the result of an excess of butter-milk in the butter, each of ten churnings of butter were divided into two lots. One lot from each churning was salted and worked without being washed. The other lots were washed with water at 48 degrees until not a trace of butter-milk could be detected in the water as it flowed from the churn. The wash-water was used colder than normal to keep the granules from uniting during the working and thus holding the butter-milk. All of these lots were worked one minute and were then set in the refrigerator for twenty-four hours. At the end of this time all lots were found to be very unevenly colored, the unwashed lots as badly so as the washed lots as far as the eye could detect. It must be admitted, however, that the light streaks in the unwashed butter were a little lighter in color than in the washed butter. But the evidence of the chemical analysis must be deemed conclusive, and as from two churnings the unsalted butter according to the analysis did not contain as much Casein as the salted lots from the same churnings, and the unsalted lots were lighter in color than the salted. Therefore it is fairly evident that a relative excess of Casein was not the cause of the lighter color and is not the cause of the light streaks in mottled butter.

The author believes that the reason why salted butter has a deeper or yellower color is because the salt has some physical action upon the fat in the butter. Salted butter admits more light than unsalted. This can be seen by cutting a thin slice of badly mottled butter and holding it between the eyes and a window or a lighted lamp. The salted and yellower portions are seen to be translucent. They allow considerable light to pass through, while the lighter and unsalted portions were opaque. This was demonstrated to the best advantage by cutting a thin slice of the prints where one half of the print was of unsalted butter and the other of salted butter. The unsalted portions allowed no light whatever to pass through while the salted part was distinctly translucent. Why or how the salt has this effect has not as yet been explained. Samples of butter were submitted to different physicists for an explanation, but they could offer none. There is a theory that fat, under certain conditions, has a varying tendency to crystalize. If this be so perhaps the salt would aid in this crystallization. This if one, would be a good explanation of the point in question.

HOW TO PREVENT MOTTLES.

As the uneven distribution of the salt in the butter is the cause of mottles, then obviously the way to prevent the trouble is to get the salt thoroughly worked in. But in doing this butter makers have experienced considerable difficulty, which is often more imaginary than real. Many butter makers who understand the cause of mottles still have difficulty because they are afraid of over working. That there is danger in over-working in some cases has been verified too many times to admit of dispute. But it is doubtful if there are many instances where the butter would need to be over-worked to thoroughly incorporate the salt. The tendency is to under-work instead of to over-work butter. Butter makers desire a coarse grain whereas a fine grain which would come with more working would be more acceptable.

Working the butter is the only way to insure its being evenly colored and how to work it sufficiently in all cases and not injure the grain, is the question. It is often advised to give the butter two workings, working it only sufficiently the first time to incorporate the salt so that it will be dissolved. The second time the butter is put on the worker after it has stood in the refrigerator for twenty-four hours it can be worked without as much injury to the grain as when it was fresh. This is the claim made by advocates of this system.

To test the result of working butter under different conditions all the butter from one churning was washed with water at 50 degrees and was given the required amount of working from 20 to 24 revolutions of the worker to insure the salt being so thoroughly distributed that the butter would be evenly colored. The next churning was washed with water from 38 to 40 degrees and worked from 21 to 24 revolutions of the worker. The third churning was washed with water at 45 degrees, worked ten revolutions of the worker and set in the refrigerator at 50 degrees for 24 hours, when it was worked from 11 to 14 revolutions in addition to the 10 revolutions of the first working. The fourth churning was taken immediately after washing and was set in the refrigerator without working, where it was allowed to remain for 24 hours. At the end of this time it was worked from 21 to 24 revolutions of the worker. This series was repeated five times in all being twenty churnings. Samples of this butter were submitted to Major Henry E. Alvord, Chief of the Dairy Division of the Department of Agriculture, who kindly agreed to score the grain. It was found on inspection that the samples from the lots washed with water at 40 degrees and below and worked 21 revolutions were slightly mottled thought Mr. Alvord gave the assurance that they were not sufficiently so to lessen the market value. The same butter worked 24 revolutions of the worker was colored perfectly.

As nothing but the grain of the butter was to be scored, a basis of 100 per cent. for perfect was used instead of the smaller basis given in ordinary scoring when all qualities are to be taken into consideration. It would be very easy however, to calculate the score given on the basis in common use.

The scores on three of the series is given in the following table:

TABLE III.

Sample.	Temperature of water	Revolutions of worker, 1st working.	Revolutions of worker, 2nd working.	Score.
1	50	21	...	98
2	50	24	...	100
3	40	21	...	100
4	40	24	...	99
5	45	10	11	98
6	45	10	14	99
7	45	...	21	98
8	45		24	96
9	50	21	...	99
10	50	24	...	98
11	38	21	...	100
12	38	24	...	100
13	45	10	11	98
14	45	10	14	98
15	45	...	21	97
16	45	...	24	95
17	50	21	...	98
18	50	24	...	99
			...	
19	40	21	...	100
20	40	24	..	99
21	45	10	11	98
22	45	10	14	97
23	45	...	21	96
24	45		24	95

In table III sample Nos. 1 and 2 came from the same churning as did three and four from the second churning and so on through the table, two samples coming from each churning. Only three series are given as the other two series were practically the same as the ones given, and would not change the general result.

A study of the table will show that the butter washed with water at 40 degrees and under, and worked 21 and 24 revolutions of the worker immediately after being taken from the churn has a slight advantage in regard to the average grain while the butter set in the refrigerator for 24 hours without any working whatever has considerably the lowest average grain. There is practically no difference in the average grain of the lots washed with water at 50 degrees and given all the working immediately after being taken from the churn and the lots washed with water at 45 degrees and set in the refrigerator for 24 hours after being partially worked. It will be remembered that this last method of partially working the butter and allowing it to harden in the refrigerator before the final working is the one usually advised by the best butter-makers to be followed in cases where there is serious trouble with mottles.

Mr. Alvord in his notes given along with the score of this butter, said that it was very doubtful if, except in a few cases, of the lowest score any of the butter would have been given other than a perfect score on grain in a contest such as is held by State Dairy Associations. The objection of Mr. Alvord to the butter scored the lowest and which the table shows were the lots which had been set in the refrigerator previous to receiving any working whatever was that it was very dry and sticky. This was noticed in working the butter. So much so that considerable difficulty was experienced by the butter adhering to the worker. This was the case with all the lots set in the refrigerator before working and it will be noticed from the table that the longer the butter was worked the more pronounced was this objectionable feature. The butter which handled the nicest on the worker, which scored the highest and which seemed to impress Mr. Alvord more favorably than any of the other because, as he said, of the fineness and compactness of the grain was that which came from the lots which were washed with water at 40 degrees and below. The only point that could be urged against this method is that it requires slightly more working to insure evenness of coloring and is a little harder to handle with the ladel while working. During the hot weather of summer it would certainly be much preferable as the working can be finished before the butter has become so soft through contact with the warm air as to render working difficult if not impossible.

EFFECT OF ICE-WATER ON SOLIDITY OF BUTTER.

There has been an objection urged by many butter makers against the use of cold wash-water or the use of extreme cold in any way connected with butter making. It is claimed that where ice water is used to wash the butter or that where ice is added to the cream during churning, the butter so treated will not "Stand up" so well comparatively under the effect of a warm temperature. In other words it would become softer or would become soft quicker when exposed to summer heat. This would certainly be a very serious objection if it were so.

Though any work along the line of testing the effects of ice and ice-water on the consistency of butter was outside of the work undertaken and which this bulletin is supposed to cover, it was deemed best to experiment along this line before advising the use of such cold water in washing butter.

To test the effect of ice-water on the butter each of ten churnings was divided into two lots immediately after the butter-milk had been drawn. One lot from each churning was washed with water at the churning temperature, from 50 to 52 degrees. The other lot was washed with water at from 35 to 40 degrees. One sample of butter from each lot was placed at a temperature of 70 degrees and another samply from each lot was placed at a temperature of 48 degrees. After standing for a day all samples were placed at a temperature of 60 degrees and allowed to stand for 4 hours, so that all samples would be the same temperature throughout. At the end of the 4 hours the temperature was gradually increased to 80 degrees. The samples were watched during this time to see which became soft the quicker and which was the softest at the end of the time. As there has been no mechanical method for determining exactly the comparative solidity of different lots of butter we were forced to rely solely on the sight and touch. This is not exact of course, but as far as all practical purposes are concerned there would be no difference in the market value of two lots of butter other things being equal where the difference in firmness could not be easily distinguished by pressure or cutting. In the work at this Station all lots of butter were found to be practically the same in consistency. Some times the lot washed with the colder water and set in the refrigerator would be found to be a little harder than the other and vice versa. In no case was the difference sufficiently marked to be used as a basis for any conclusions or even suspect that one method was superior to the other. It was noticed, however, that samples of the butter whether washed with the water at 50 degrees or 35 degrees, if put in the refrigerator retained its firmness when exposed to summer heat a little better than that which had been kept at a warmer temperature. Though after all lots had been held at 80 degrees for two hours no difference in consistency could be distinguished. Whether this firmness of the samples which had been kept in the refrigerator was due to the treatment at the time of churning and washing or because insufficient time was allowed for all the butter to get to 60 degrees while it was being held at this temperature is questionable.

As was stated at the beginning of this Bulletin one of the most frequent questions asked at this Station was concerning the cause of unevenly colored butter. The great majority of questioners are dairy farmers who own a few cows and make their own butter. The great need on the small dairy farm is better facilities, more tools to work with. It is because of the lack of what are almost necessities for handling the product that so much difficulty is experienced in making butter that commands the best market price. The principal reason why the small dairyman has so much unevenly colored butter is because he has no tools with which the butter can be properly worked. The old-fashioned butter bowl and ladle are still in universal use on the smaller dairy farm. Where but three or four pounds of butter are made at one time for the family use the butter bowl may be sufficient but where more than this is made and made to sell it is impracticable if not impossible to work the salt in evenly without some more advanced way of handling the product. A number of small inexpensive machines for working butter are sold by different firms who handle dairy apparatus. Any one of these is superior to the hollow bowl and spoon.shaped ladel.

CONCLUSIONS.

1. The uneven distribution of salt is the cause of unevenly colored butter spoken of as mottled butter.

2. Washing the butter with water below 40 degrees does not cause mottles. It does, however, make a little more working necessary to thoroughly distribute the salt.

3. The light colored streaks or portions of mottled butter are not caused by an excess of casein, but mottles is evidently caused by some physical action of salt on the butter fat which causes it to admit more light.

4. Mottles can be prevented by working the butter sufficiently to thoroughly distribute the salt.

5. Butter washed with water at 40 degrees and under and worked immediately shows a better grain when sufficiently worked to insure its being evenly colored than with any other treatment.

6. Washing butter with water at 40 degrees and under does not injure its firmness when subjected to high temperature.

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"	"	6, Sept.,	1889,	Commercial Fertilizers.
"	"	12, March,	1891,	Pig Feeding.
"	"	22, Sept.,	1893,	Steer Feeding; A Well Balanced vs. A Poorly Balanced Ration.
"	"	24, Feb.,	1894,	Composition of Commercial Fertilizers sold in this State.
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"	"	31, March,	1895,	Potato Experiments.
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"	"	33, April,	1895,	Horticultural and Agricultural Departments; Small Fruits, Vegetables and Field Corn.
"	"	34, July,	1895,	Composition of Commercial Fertilizers sold in this State.
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BULLETIN NO. 65
OF THE
MARYLAND AGRICULTURAL
EXPERIMENT STATION,
COLLEGE PARK, MD.,

March, 1900.

THE
Maryland Agricultural Experiment Station.

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THE MARYLAND
AGRICULTURAL EXPERIMENT STATION.

BULLETIN NO. 65. MARCH 1900.

SOME IMPORTANT INSECTICIDES, FUNGICIDES AND APPARATUS FOR THEIR APPLICATION.

By W. G. Johnson, C. O. Townsend and H. P. Gould.

GENERAL INTRODUCTION.

In the preparation of this bulletin the authors have endeavored to answer the more important questions that are asked eash season about insects and fungi, insecticides and fungicides and the apparatus now generally used for their application. A spray calendar (see page 85) especially adapted to this state, is also appended, with a hope that it will serve as a guide to the fruit grower and trucker.

At the present time, spraying is an important part of successful fruit growing. The regular and systematic application of insecticides and fungicides is one of the most valuable and profitable pieces of work done on the farm. The spray pump, properly used, is worth as much to the grower of fruits and vegetables, as the policy covering the insurance on his house or barn. In fact, you must "insure" your crops from destructive insects and fungi, by practicing modern methods of spraying. There has been a decided awakening to the truthfulness of the above statement in the past few years, and thousands of growers are now spraying and seeking information, where only a short time ago they were counted by hundreds.

The authors will cheerfully answer any inquiry along their respective lines not clearly explained in the following pages.

This bulletin is published out of the funds appropriated for the State Horticultural Department, being the third of this series, and is distributed by the Experiment Station in accordance with the Laws of Maryland 1898, Chapter 189.

SOME IMPORTANT INSECTS AND INSECTICIDES.

By Willis G. Johnson.

Introductory.—In order that our readers may understand why one remedy is used for one insect and not for another it will be necessary for us to make some brief references to the structure and habits of certain types. For example, the great mass of injury to plants by insects falls under two heads; first. where the plant itself has been eaten, and second, where the juices have been sucked out leaving the tissues.

Biting Insects.—Insects causing injury of the first class are called biting or chewing insects, familiar examples of which are the beetles, grasshoppers and caterpillars, such as the cabbage worm, army worm, etc. They have well developed jaws fitted for cutting and chewing the plant. Such insects can be destroyed by use of direct poisons, such as the arsenicals. Where applied to the leaves or other parts of the plant it is eaten by the insect, causing its death.

Sucking Insects.—On the other hand, the second type have long lance-like beaks fitted for sucking. This class includes the scale insects, plant lice, squash bug, harlequin or terrapin bug, etc. They obtain their food supply by inserting their beaks into the tissues of the plant, sucking the juices from within. The external application of arsenical poisons to plants would have little if any effect upon this group of insects, as the poisons do not enter into the cells of the plants. It is necessary, therefore, to employ some other substances for their destruction. To this end materials are used which will act externally on the bodies of the insects, either as a caustic or to smother or stifle them by closing their breathing organs. I might say in this place that insects do not breath through their mouths as do higher animals, but through small openings on either side of the body called spiracles. By spraying anything of a caustic or oily nature over the body of an insect these spiracles are closed and the creature is destroyed. Sometimes the fumes of poisonous gases are employed to suffocate insects, as will be described later on. Insects are sometimes repelled by obnoxious substances.

The above remarks apply especially to insects which feed upon the exterior of plants or pass the greater portion of their lives in an exposed condition, where they can be readily reached by one of the methods mentioned. Certain other insects, of both classes, biting and sucking, are subterranean in their habits, that is, they feed and live upon the roots of plants below the surface of the ground. Among these the white grub, and root lice are common examples. Still other insects live in stored grain, seeds and the manufactured products of the mill, and even the mill itself. Here again the arsenics and irritants cannot be used and we must resort to various fumes and gases.

WHAT ARE THE EXTERNAL POISONS FOR BITING INSECTS?

For the destruction of insects coming under the general head of biting insects the arsenical compounds have practically supplanted all others*. Those in most common use are Paris green and London purple. Still other compounds are coming into general use, among which we recommend arsenate of lead and green arsenoid. We do not advise, under any circumstances, the use of pure white arsenic.

Paris Green.—This is a green, rather coarse powder, and is composed of arsenic, copper and acetic acid (known as aceto-arsenite of copper). It does not remain in suspension long in water and this is its chief fault. It can be purchased at 16 to 20 cents per pound, the price varying with the amount bought. There are some adulterated grades upon the market sold for a less price, but these should be avoided. In some cases these low grades are sold for the best. Last July we found one of these adulterated compounds on the Eastern Shore of Maryland and had the director of the Experiment Station make a chemical analysis of it. It contained only 31.6 per cent. of arsenous acid; where, theoretically, it should have contained 58.6 per cent. For commercial purposes Paris green is considered pure when it contains not less than 50 per cent of arsenous acid. If you have reason to suspect that the material you are using is not what it should be, send a sample to the Experiment Station, giving such facts as you can, as to who manufactured or sold it.

London Purple.—This is a waste product obtained in the manufacture of analine dyes, and its composition is, therefore, not the same in all cases. There are several chemicals in this compound, chief among which are arsenic and lime. A greater per cent of the arsenic is soluble in Paris green, and consequently, there is more danger of injuring the foliage when London purple is used. It is a very fine, purplish powder and kept in suspension in water more easily than Paris green. It costs less than Paris green, the price being from 12 to 16 cents per pound. As a rule London purple is not so generally adulterated as the Paris green.

Arsenate of Lead.—This is a comparatively new insecticide, is white in general color, and when sprayed upon foliage may be distinguished at a glance. There is not much danger of burning the foliage with this material and it adheres more readily than Paris green or London purple. It is composed of arsenate of soda and acetate of lead. It costs a little less than the Paris green. It remains well in suspension, and the fact that it is harmless to foliage makes it a valuable substance. It is now manufactured and placed on the market at 15 to 18 cents per pound. It forms almost a pure white precipitate of pasty consistency.

Green Arsenoid.—This material is a substitute for Paris green and is applied in the same manner. It is more bulky than Paris green and contains no acetic acid; and is not, therefore, so apt to burn foliage. It can be used in solution or dry. It has been tested thoroughly by several Experiment Stations and has the decided advantage over Paris green (1) in costing less, 13 to 15 cents per pound, and (2) in being a very fine pulverant powder, which remains easily in suspension when in water.

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*Hellebore is generally used as a remedy against certain biting insects, but as it is not an arsenical compound it has not been included under this head, and is listed with the powders on page 62.

HOW ARE THESE POISONS APPLIED?

The arsenical compounds are applied in three different ways, namely: (1) wet, (2) dry, and (3) poison baits. The first method is most commonly used and is best adapted for the protection of orchards, shade trees, etc. The dry method is used extensively in the south for combatting the cotton worm and is feasible on low growing crops, such as potatoes, cabbage, etc. The third method is used for destroying cut worms, wire worms, etc.

The wet method.—Either Paris green or London purple may be used in water, for general purposes, at the rate of one pound to 160 gallons of water, or one ounce to 10 gallons. First put the poison in some small vessel, add a little water and stir until a thick paste is formed, then slake an equal quantity of good stone lime and stir this into the poison. The lime lessons the danger of burning the foliage by taking up the free arsenic. Twice the quantity of lime will do no injury. The lime is especially desirable where the delicate foliage of peach and plum is sprayed. After the poison and lime have been prepared they should be stirred in the proper amount of water. The arsenate of lead is used without lime.

It is now a very common practice to use the same amount of poison in Bordeaux mixture instead of using water; thus spraying for both insect pests and fungous diseases at the same time. Usually four ounces (¼ pound) of poison in a barrel (40 gallons) of Bordeaux is recommended. For method of preparing Bordeaux mixture see page 67.

The Dry Method.—Very often it is desirable to use Paris green dry. It should then be mixed thoroughly with land plaster, air slaked lime or common wheat flour. For general purposes one pound of poison to 100 pounds of diluting material is used. When only small quantities are needed, mix one-ounce of poison with six pounds of either lime, plaster or flour. If used on low growing plants, the mixture can be placed in an old fertilizer bag and distributed evenly by merely shaking the bag. This should be done early in the morning when the dew is on or immediately after a rain. In small garden patches, an old vessel with perforations in the bottom can be used as a "shaker".

There is also upon the market an apparatus especially devised for the dry application of this poison. One of these dry powder guns is shown in the illustration, Figure 29, page 83. Larger patented air-blast machines are frequently used in the south in cotton fields. The "bag and mule" method is, however, most commonly used. On tobacco, the dry method is very satisfactory, using land plaster about 100 pound for every pound of Paris green.

The Poison Bait.—Where it is not desirable to place the poison directly upon the plant, the poison bait can be used to good advantage. It is a well known fact that cut-worms, wire-worns, grasshoppers, etc., have a liking for sweetish substances. We know also that these creatures eat bran with a relish. By combining the bran with molasses, or syrup made from sugar we have an ideal bait, and the worms will eat it in preference to anything else when it is available. By poisoning this material with Paris green we have a good remedy, cheap and easy to apply. The ingredients used for making the poison bait are as follows:

Wheat bran	50 pounds.
Molasses, (any kind)	2 quarts.
Paris green, (good grade)	1 pound.
Water	(Enough to make a thick mash)

The bran should be placed in an old tub or barrel, and to this the Paris green should be added and stirred thoroughly with a shovel or other implement before the water or molasses is poured in. Stir the molasses with about a gallon of warm water and pour it over the bran and Paris green, thoroughly stirring until it is well mixed. Then add enough water to make a mash, about the consistency of dough, so that it can be handled easily without running. The materials having been prepared, it is now applied to land to be planted in tobacco, tomatoes, cabbage or other crops, and to do this successfully, several essentials are necessary.

1. Land, if sod or grass, should be prepared several days in advance.

2. After the drills are made a pinch of poison mash, about as much as one could hold on a table spoon, should be dropped in the vicinity, (not in the exact place) of the spot where the plant will be set. This should be done before the plants are set out.

3. The application should be made in the afternoon, as near evening as practicable; but where it is necessary, in order to get over large areas, there is no objection to dropping it any time during the day.

4. Care should be taken to keep chickens, turkeys, or animals of any kind that would be liable to eat the mash, out of the field for a day or two, or until after the plants are set.

One of our correspondents who used this method on his tobacco land said: "The cut worms came up readily, ate it and were killed before the tobacco was planted." He said five or six dead worms were often found to a hill.

WHEN IS THE TIME TO SPRAY WITH ARSENICALS?

As a general rule, the first spraying is made, for the destruction of codling moth (or apple worm) of the apple or pear, immediately after the falling of the blossoms. The second spraying should be made a week to twelve days later, just before the fruit turns down on the stem. These two sprayings are the important ones, so far as the codling moth is concerned. If the spraying has been properly done there will be a film of poison solution over the calyx or eye end of the apple, and when the worm endeavors to enter, and it most always goes to the calyx end, it gets its poisonous dose and is destroyed. If the spraying is delayed until after the apple or pear turns downward, then it is too late, as very little good can be expected so far as wormy fruit is concerned.

For leaf eating insects the spray should be applied when the first creatures are discerned. In case of the potato, tomato, cabbage, sweet potato, and other low growing crops, it is not best to wait until the pests appear; but spray early and often to keep them from multiplying. The destruction of the early brood means thousands later in the season. Never spray your trees when they are in blossom, on account of destroying honey bees and other useful insects. The bee is useful in that it fertilizes the fruit.

Caution.—In using any of the arsenical compounds, whatever manner you apply them, bear in mind they are poisonous, and should be so labeled. If used as directed above, there is absolutely no danger attending their application. The poison disappears from any plants upon which it is sprayed within 20 to 25 days; and even if the plants were eaten immediately after the spraying, there would be no danger of poisoning. To illustrate in the case of the apple, it has been estimated that a person would have to eat several barrels at a time to get a poisonous dose; and with cabbage, dusted as recommended, about twenty-five large heads, at one meal, might prove dangerous if eaten by one person; but even in this event death would not result from poisoning.

In all your work never use more poison than is recommended. Follow directions as closely as possible. The philosophy of the old colored man, who reasoned that if a quarter of a pound of Paris green in 40 gallons of water, would kill the bugs on his cabbage "dead", a half a pound ought to "kill them deader", should not be followed for fear of killing the plants also.

WHAT ARE THE MATERIALS FOR DESTROYING SUCKING INSECTS?

The remedies for the destruction of sucking insects are simple,but need the same care in their preparation and application that attend the arsenicals. The standard materials used for sucking insects are: (1) soap, (2) kerosene, (3) crude petroleum, (4) tobacco, (5) insect powder, (6) sulfur,* (7) bisulfid of carbon, (8) hydrocyanic acid gas, etc. We will briefly discuss each of these substances.

Soap Solutions.—Any good soap is effective for the destruction of soft bodied insects; but those made of fish oil, commonly sold under the name of whale oil soaps, are most generally used, and are best adapted for spraying. There are several brands and grades of whale oil soaps upon the market, selling from 3 to 5cts per pound, the price depending on the quantity purchased We have found the soap made with caustic potash very much better than those made with caustic soda. In ordering the soap, insist upon having a good grade made with caustic potash.

For plant lice and delicate larvae, such as the pear slug, dissolve one half pound of soap in a gallon of water and spray thoroughly. Any ordinary soft soap, made upon the farm, can be utilized, but double the amount should be used.

As a winter wash, the whale oil soap has no superior, as a remedy against the San Jose scale and other scale insects. It should be applied in the fall, winter or early spring, while the trees are dormant, using $1\frac{3}{4}$ to 2 pounds to a gallon of water. It should be put on with a good sprayer, and while hot. Where a large number of trees are to be sprayed, the soap should be dissolved in large iron vessels, and thoroughly strained before being placed in the sprayer.

Kerosene Solutions.—Kerosene emulsion has long been an effective remedy for certain insects; but not until recently has an apparatus been designed for mechanically mixing oil and water, thus doing away with the old method of making the emulsion. We have found these combination kerosene sprayers very satisfactory, and have used and tested the bucket, knapsack and barrel types. For an account of this apparatus see page . The water is placed in one tank, the kerosene in another and by setting a gauge, the desired percentage is obtained. If you already have a sprayer of the old type, you can make the emuslion according to the following directions.

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*The spelling of various chemical terms used in this bulletin is in accordance with the Standard Dictionary and is now generally adopted. Thus sulphur is now spelled sulfur.

Hard (or soft) soap (ivory soap preferable)	One half pound.
Water (rain water if convenient)	One gallon
Kerosene (common coal oil)	Two gallons.

Put the water in a vessel holding four or five gallons, add the soap by shaving into thin pieces, place on a stove and bring to the boiling point, occasionally stirring it to dissolve the soap; then remove to the yard, or some convenient place away from the fire, and pour the kerosene directly into the water. This should then be pumped in and out of the vessel with a good force pump for from 5 to 10 minutes, or until the emulsion is formed. If properly made, it will have the appearance of buttermilk, and will readily mix with water without any oil coming to the surface. It will keep an indefinite length of time, becoming a semi-solid compound when cold. If used when fresh it can be diluted with cold water to the strength desired; but if cold and hard, warm water should be used. For plant lice every gallon of the emulsion should be diluted with from 10 to 12 gallons of water, and applied with a good spray pump.

Under no circumstances do we recommend the use of pure kerosene upon plant life of any kind. This material has been used, undiluted, by some persons, without any apparent injury to the tree; but there are so many uncertainties attending its use, we do not consider it safe and do not recommend it.

Tobacco.—Tobacco may be used as an insecticide (1) in powered form, (2) in solution, or (3) burned. Finely ground tobacco known commercially as tobacco dust is a powerful insecticide. It is often used around trees affected with root-lice. Two or three inches of the surface earth is taken away from around the trees and about 1½ to 2 pounds of tobacco dust evenly scattered over the surface and afterward covered with dirt. The first application should be made in June, and if necessary repeated in August. This remedy is very effective against the black root Aphis of the peach and the woolly Aphis of the apple. The dust shaken over plants infested with delicate larvae and plant lice is also destructive to insect life.

In making a decoction cut up the old stems and leaves, add water and boil down until a strong solution is obtained. It can be sprayed directly upon the plants. Tobacco smoke is fatal to insects breathing it, and, very often, is used in enclosures infested with plant lice or other delicate insects. Good results have been obtained where tobacco stems have been thrown around trees.

For the San Jose scale we find a 20 to 25 per cent mixture of kerosene and water most satisfactory. For peach and plum the 20 per cent mixture is recommended. Apple and pear will stand a much stronger mixture. It can be put on most effectively when the trees are dormant; but can be applied in 20 per cent mixture even when the trees are in full foliage. This is, at present, the cheapest, and most satisfactory remedy against the San Jose scale in bearing orchards.

Crude Petroleum.—This substance has been recommended and used recently against the San Jose scale. The crude oil is sprayed upon the tree while it is dormant. It is no doubt, an effective remedy, but the expensive nature of the crude oil at present, bars it from general use in extensive orchards. It costs from 8 to 13 cents per gallon in barrel or car load lots. When a gallon of this material undiluted, costing, say 10½ cents, is compared with a gallon of refined kerosene costing the same amount, which can be diluted to make 4 gallons of spray, the reasons for not using the crude product are plain. In small orchards, and where only a few trees are to be treated, the crude petroleum can be used to good advantage. It will kill the scale, and whether it is used or not depends upon circumstances and the individual applying it.

*Hellebore.**—The roots of the white hellebore, *Veratrum viride,* are powdered and used as an insecticide, particularly as a substitute for the arsenites. When a few plants are involved this substance is useful; but too expensive for large operations. It destroys insect life, like arsenicals, as an internal poison, and should properly have been placed under that groupe of materials. It is less dangerous to man and higher animals, but would cause death if a sufficient quantity was taken. For cherry slug, rose slug, currant worms and strawberry worms, the powder can be dusted over the plants, diluted with 5 to 10 parts of flour. The application should be made when plants are moist with dew. If used as a spray, 1 ounce to a gallon of water is sufficient.

Insect Powder.—The material usually known as insect powder, is known also as Buhach or Persian insect powder. It is the ground up flowers of the Pyrethrum plant. The flower resembles, somewhat our common field daisy. It is now manufactured extensively in California. The killing property of the material is a volatile oil and it should therefore be kept in air-tight vessels. It is not poisonous to man or the higher animals, hence it can be used where poison could not. Its great value is against household pests, such as flies, ants, cockroaches, fleas etc. In small conservatories it can be used to good advantage where poisons are not desireable. It is used as a dry powder or diluted with flour and may be dusted or puffed about a room or over plants. The powder is sometimes burned in an enclosure to destroy mosquitoes quickly. It may be also used in water at the rate of one ounce in 12 gallons of water and should stand about 24 hours before using. For immediate application it can be used in hot water.

Sulfur.—Flowers of sulfur is one of the best remedies for mites, such as the red spider etc. It should be applied at the rate of one ounce to a gallon of water or mixed with some such solution as kerosene emulsion. In green-houses a little sulfur sprinkled over the ground occasionally is desirable. If the house contains steam or hot water cover the upper surface of the pipes with sulphur. Burned in poultry houses it is an excellent remedy for the destruction of vermine. Mixed with fresh lard, oil or other grease is a good remedy for lice infesting animals when rubbed over them. Add a little sulfur to the feed of such animals occasionally.

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*This substance properly belongs to the group of biting insects cited on page 57.

Bisulfid of Carbon.—This is a foul smelling liquid as clear as water, very volatile, and with fumes heavier than air. It creates a death atmosphere in which no creature can live. It is a specially desirable material for the destruction of insects in stored grains and seeds. A grade, known as "Fuma Bisulfid of Carbon" is sold at about 10 to 12 cents per pound in 25 to 100-pound cans. It can be thrown directly upon the grain or seeds without injuring them either for planting or for edible purposes. For wheat in store, one pound of bisulphide is sufficient for every 100 bushels. If an enclosure is fumigated use one pound to every 1000 cubic feet of space. Place the liquid in a dish or pan and set it on top the grain, making the enclosure as tight as possible. Leave the building closed for 24 hours or longer if possible. Have no lights, not even a lighted cigar or pipe, around when fumigating. Do not inhale the fumes too freely; but get out as soon as possible after the material is applied. It is so inexpensive and so easily handled there would seem to be no good reason why a farmer should have weevily wheat or corn if he has a good tight bin or crib. It is also used in some countries, especially France, for the destruction of under ground insects such as Phyloxera on roots of grape. It is also used to destroy rats and gophers in their burrows in the ground.

Hydrocyanic Acid Gas..—This is one of the most deadly gases known to chemical science, and must, therefore, be used very carefully. It is made by combining cyanide of potassium, sulfuric acid and water. This gas is now extensively used by nurserymen for the fumigation of fruit trees to preclude the possibility of sending out some undesirable insect. It is also used in the orange growing sections of California, Florida, South Africa and other places for the destruction of certain insects upon the trees and fruit. It is now used to some extent in the orchards of the Eastern United States. As a remedy for certain pests in green-houses, dwelling houses, mills, store houses. railway coaches etc., it has no superior as a destroyer of animal life. It diffuses quickly, is lighter than air and very penetrating. It leaves no after and bad effect in a building. It will be more universally used in the future. Persons desiring to use this gas should write to us for more specific information. Its application will admit of no carelessness or guesswork as it is too deadly a poison with which to fool.

There are many patent insecticides, and other materials upon the market, which cannot be mentioned in this bulletin for want of space. The author however, will answer any inquiry about such substances when requested to do so.

SOME IMPORTANT FUNGI AND FUNGICIDES.

By Charles O. Townsend.

Introductory.—In presenting this part of the bulletin the writer has considered it advisable to take up some of the more important questions that have been asked from time to time, in regard to the fungi and fungicides and to answer them as briefly and as pointedly as possible.

WHAT IS A FUNGUS?

A fungus (plural fungi) is a low form of plant. It has neither green stem nor leaves and therefore depends for its food upon other plants or upon animals. Sometimes fungi live upon dead plants or animals or upon their products, and sometimes they live upon other living plants or upon living animals. They are very numerous and differ greatly among themselves in form structure and habits of life. All fungi sooner or later produce small round or oval bodies called *spores*. These spores under favorable conditions produce new fungi. They are not destroyed by ordinary weather conditions and often live over the winter in the fields and orchards. Sometimes they remain alive for several years in the soil and other suitable places, and begin their growth when the conditions are favorable. Many fungi are very small and can be seen only when greatly magnified.

WHAT IS THE HOST PLANT?

The host-plant is the plant upon which, or in which the fungus lives and from which it draws its food supply.

WHAT IS A FUNGICIDE?

A fungicide is any substance which may be used to destroy fungi or their spores or which will prevent fungi from establishing themselves upon the host plants. Fungicides may be either solids, liquids or gases. The most common form of fungicide is liquid; the kind of fungicide used however must depend upon the nature of the fungus, the nature of the host-plant, and the part of the host-plant attacked by the fungus.

WHY SHOULD WE SPRAY?

Liquid fungicides are best applied in the form of a fine mist or spray.

This is economy both in the quantity of material used and in the time required to apply it. The real object in spraying is to prevent the fungous spores that have lodged upon the foliage, branches or fruit, from germinating and producing fungous growths. Every fungus that grows into a leaf or into a fruit and thus produces the destruction of the former or the decay of the latter first lodges on the leaf or on the fruit as a tiny spore. If that spore can be destroyed without injury to the leaf or to the fruit, disease may be prevented, and therefore the necessity of spraying.

WHY SHOULD WE SPRAY EARLY?

As already stated fungus spores are sometimes formed in the fall and remain in open fields all winter uninjured. These spores often lodge in the crevices of the bark of trees or in other convenient places on the trunks and branches of trees. When the leaves and fruits appear the spores are blown onto these newly formed parts and cause them to be diseased. The object in early spraying, even while the trees are still dormant, is to kill the spores that are lodging on the tree and waiting for favorable conditions for development. Again, every spore must remain for a longer or shorter time in a dormant state even after it reaches the proper place for its development, just as seeds remain for a little time under proper conditions for germination before they begin their growth. If the leaves or other plant parts are covered with a fungicide before or immediately after the spores are blown onto them, the spores will be destroyed and the plant will remain free from disease.

WHY IS IT NECESSARY TO SPRAY MORE THAN ONCE?

After a plant has been sprayed new leaves or fruits are often formed which are not covered with the fungicide. Spores may be lodged on these newly formed parts and develop into fungous growths causing the parts attacked to be diseased. Or the fungicide originally sprayed onto the plant may be washed off by rains thus leaving the plant unprotected against the spores that are constantly carried about in the air.

HOW OFTEN IS IT NECESSARY TO SPRAY?

No definite rule can be given in regard to the number of times any set of plants should be sprayed in a single season. The number of sprayings must depend to a large extent upon weather conditions. Warm, damp weather or a dry, hot season followed by rain, are favorable conditions for the development of fungi, hence if these conditions prevail it is important that the spraying should be frequent enough to keep well protected the parts liable to attack. Sometimes it is necessary to spray every day or every two or three days while at other times ten days may elapse between sprayings. Spraying like cultivation, pruning, and other field operations is largely a matter of judgment, and the more thoroughly the subject is understood the more effective the work will be.

WHY IS IT NECESSARY TO SPRAY EVERY YEAR?

It is impossible to exterminate fungi. We may hold them in check, or we may even prevent entirely their growth upon certain plants; but they are often so small, their habits of life so variable, and their spores so resistant that extermination is out of the question. It is impossible to know at the beginning of the season whether the conditions will be favorable or unfavorable for the development of fungi, hence in order to be on the safe side it is necessary to begin each season with spraying. It is essential, therefore, that spraying should be as regularly a part of the field work for successful crop raising as plowing, fertilizing, and the other operations necessary for crop production. Furthermore the effects of spraying are cumulative, that is the effects of spraying and keeping fruit trees free from disease this year will give a better crop next year. Even with trucking crops that die down in the fall the danger from disease next year in a particular field will be greatly reduced if the field is kept free from diseases this year.

DOES SPRAYING SOMETIMES INJURE FOLIAGE AND FRUIT?

If fungicides are not properly made they will burn the foliage and discolor the fruit. It is a well known fact that the foliage on some plants is much more tender than it is on others, and for this reason it is necessary to suit the strength of the fungicide to the host plant. Certain fungicides like Bordeaux mixture can not be used in spraying fruit that is nearly ripe since the fruit would be stained by the mixture and thereby rendered unsalable.

WHY DOES SPRAYING SOMETIMES FAIL TO PREVENT DISEASE.

There are several reasons why spraying sometimes fails to accomplish the results expected. It may be that the fungicide was not properly made, that the spraying was not done early enough in the season, or that the applications were not thorough or persistent enough. If we wait until we see the disease at work before we begin spraying onr efforts will not result in success, for the reason that when we see the disease it is certain that the fungus spores have germinated and the fungus has grown into the affected part of the host-plant. In such cases it is impossible to destroy the fungus without destroying the diseased part of the host. The most that can be hoped for in such cases is that the disease may be prevented from spreading to the healthy plants or plant parts. If the spraying is not thorough so that all parts of the host are covered, spores may fall upon the unprotected parts and grow as readily as if no fungicide had been used. Or if the applications are not frequent enough so that the fungicide is washed off, or new plant parts are developed and left unsprayed, attacks of fungi may take place as readily as if no spraying had been done. It should be remembered that no fungicide will restore any plant part once destroyed or injured, hence the necessity of preventing attacks of fungi, and this can be done only by an early, thorough, and persistent use of fungicides.

WILL SPRAYING PREVENT ALL PLANT DISEASES?

Several plant diseases, of which "peach yellows" is an example, are not, so far as known, produced by organisms, and these diseases can be neither prevented nor controlled by fungicides.

Other plant diseases are produced by bacteria that live in the tissues of diseased plants. These minute organisms seldom appear on the surface of the host plant and consequently would not usually be reached by spraying. Such a disease is the pear blight. It is often the case that a disease attacks only the under-ground portion of the plant. It is clear that a disease of this nature could not be prevented or controlled by spraying. Potato scab is an example of diseases of this kind. In short, it is only those fungous diseases that originate from spores on the above-ground portions of plants that may be prevented by spraying.

WILL IT PAY TO SPRAY?

Whether it will or will not pay to spray must depend upon circumstances. It is of prime importance to know whether the plants under consideration are subject to diseases that may be prevented by spraying. If so and the crop is worth raising at all, it is worth bringing to the highest possible state of perfection and it is now well known that spraying, if properly done, is one of the important factors in perfect crop production. However, unless one makes up his mind to use all possibie pains in the preparation of fungicides, to begin spraying early and to carry it on persistently, the time, labor and money expended will be lost. On the other hand, if the fungicide is properly prepared and the work is timely and thorough, it is probable that no equal amount of labor and money expended will yield larger returns, taking it year in and year out. This statement has been demonstrated many times by farmers, gardeners and fruit growers in nearly every section of the state. It is true that certain seasons are unfavorable for the development of fungi, but it rarely happens that they do not develop to some extent; hence it will be an advantage to spray even during such seasons. Experience has shown that it pays to spray systematically and thoroughly, year after year regardless of the season.

HOW ARE FUNGICIDES PREPARED?

The following directions may be observed in the preparation of common fungicides:

Ammoniacal Carbonate of Copper.—Dissolve five (5) ounces of copper carbonate in just enough ammonia water to dissolve it and mix the solution thoroughly with forty (40) gallons of water. In dissolving the copper carbonate it is advisable to dilute the ammonia with eight times its own volume of water. The amount of ammonia required to dissolve five (5) ounces of copper carbonate will depend upon the strength of the ammonia. It will be about three (3) pints. Care should be taken not to add too much ammonia water as an excess will burn the foliage. If properly made this forms a clear fungicide that does not stain the foliage or fruit.

Bordeaux Mixture.—Place six (6) pounds of copper sulfate crystals in a coarse bag and suspend it just below the surface of the water in a tub containing twenty-five (25) gallons of water . In a second tub slake six (6) pounds of good stone lime and add enough water to make twenty five (25) gallons. Now pour the two solutions at the same time into a barrel or into the spray pump as shown in Fig. 12, and stir thoroughly. It is advisable to pour these solutions through a sieve of about thirty meshes to the inch. This will tend to mix the solutions more thoroughly and also to remove any particles that might clog the spray nozzle. If these solutions are properly mixed they will hold up as shown in the cylinders in Fig. 13, marked Bordeaux mixture properly made. Otherwise the solid particles will fall as in the cylinders marked Bordeaux mixture improperly

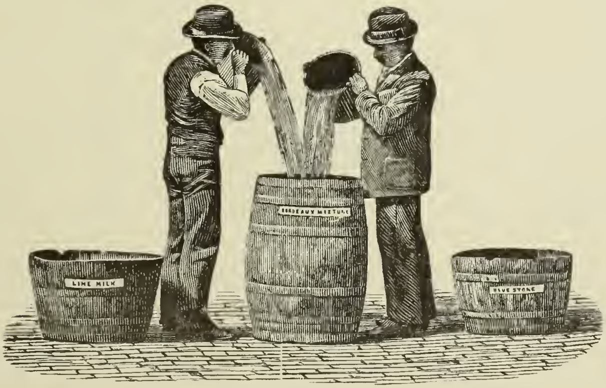

FIG. 12—Proper method of preparing Bordeaux mixture (U.S. Dept. of Agriculture, Division of Botany, Bulletin No. 38.)

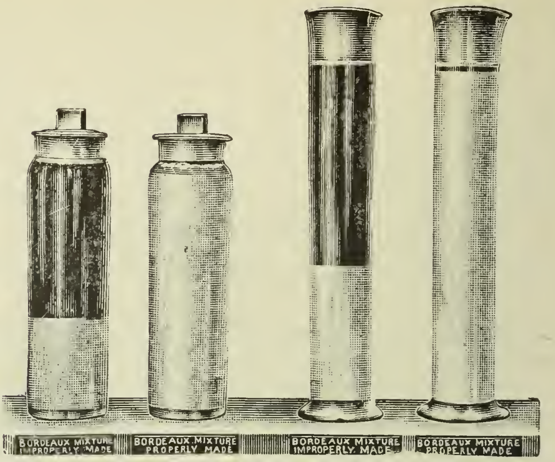
BORDEAUX MIXTURE IMPROPERLY MADE
BORDEAUX MIXTURE PROPERLY MADE
BORDEAUX MIXTURE IMPROPERLY MADE
BORDEAUX MIXTURE PROPERLY MADE

Fig. 13—Bordeaux mixture properly and improperly made. (U. S. Dept. of Agriculture. Division of Botany, Bulletin No 38.)

made, (Fig.13). This mixture should be used as soon as it is prepared as it quickly loses its strength. If considerable Bordeaux mixture is required for the season it is a great saving of time to prepare stock solutions which may be kept on hand for several weeks. To make stock solutions dissolve fifty (50) pounds copper sulfate in fifty (50) gallons of water. In another barrel slake fifty (50) pounds of good stone lime and add enough water to make fifty (50) gallons. These barrels should be tightly covered to prevent evaporation. When it is desired to make a barrel of Bordeaux mixture stir the stock solution thoroughly, dip six (6) gallons from each barrel and place in separate tubs. Now dilute each to twenty-five (25) gallons and pour together as already directed. The use of the lime is to combine with the copper and form a compound that will not burn the foliage. It also tends to make the fungicide adhere to the plant upon which it is sprayed. To test the mixture to see if all the copper is combined with the lime add a drop of potassium ferro cyanide solution. If it changes color upon coming into contact with the Bordeaux mixture more lime should de added; if it does not change color the combination is complete. In using Bordeaux mixture upon peach or plum foliage it is better to use only four (4) pounds of copper sulfate per barrel instead of six (6). This is the most common fungicide in use at the present time, but it must be remembered that it stains the foliage and the fruit and should therefore not be used when the fruit is approaching ripening season.

Copper Sulfate.—Dissolve three (3) pounds of copper sulfate crystals in hot water and dilute to fifty (50) gallons. This is much more easily applied than Bordeaux mixture but it does not adhere so firmly and it *must never be used except while the trees are dormant.* It is useful also in spraying benches and the general interior of green-houses.

Corrosive Sublimate.—*This substance is a deadly poison.* It is prepared by dissolving two ounces of the crystals in sixteen (16) gallons of water.

Iron Sulfate.—Dissolve from one (1) to four (4) pounds of the crystals in one (1) gallon of water. If it is required as a spray one pound per gallon is sufficient and the solution should be used only while the plants are dormant. If it is to be used as a wash four (4) pounds per gallon gives the proper strength. If a saturated solution of Iron sulfate is required, it is best to add one part of sulfuric acid to each 100 parts of water.

Potassium Sulfid (Liver of Sulfur).—Dissolve four (4) ounces in from four (4) to sixteen (16) gallons of water.

Sulfur.—In the dry powdered state this is known as flowers of sulfur. It may be sprinkled over the plants in the dry state or it may be converted into fumes by heating. Care should be taken not to heat it to the burning point as it would thereby form a compound that would destroy green plants as well as fungi. It is usually sufficient to place it upon the hot pipes of the green house.

Sulfur and Lime.—Mix the flowers of sulfur with equal parts of powdered lime. This may be used in the same manner as the pure sulfur.

IN ADDITION TO USING FUNGICIDES WHAT PRECAUTIONS SHOULD BE USED TO HOLD FUNGI IN CHECK?

Healthy seed and healthy stock are the first requisites for healthy plants. Having secured seeds that germinate readily and vigorously or plants that are not tainted with disease it is important that they should be planted in suitable soil and properly cultivated. The soil should not only contain the necessary food material and the proper amount of moisture but it should be free from fungus spores. If the soil becomes filled with disease-producing spores, plants upon which those spores will germinate and produce disease should not be grown in that particular field for several years. i. e. the crops should be rotated.

It is sometimes possible to make plants outgrow attacks of fungi, for example, from fifty (50) to one hundred (100) pounds of Nitrate of soda per acre sowed broadcast over strawberry plants in the spring will sometimes cause the leaves to outgrow the blight. Badly diseased plants of any kind should not be plowed down but should be gathered and burned. Plants and plant parts especially leaves and fruits that are diseased should not be allowed to remain on the ground or on the trees over winter, either in the field or orchard, but they should be gathered in the fall and burned. Plants affected with incurable, infectious, or contagious diseases should be promptly rooted out and burned.

DOES FUMIGATING WITH HYDROCYANIC ACID GAS PREVENT FUNGUS DISEASES?

Hydrocyanic acid gas is an insecticide and has no effect upon fungi and fungus spores when used in the ordinary process of fumigating nursery stock or orchard trees. Hence it must be remembered that fumigating with the gas does not reduce, in the least, the necessity for good, thorough spraying with some carefully prepared fungicide.

WHERE CAN WE GET FURTHER INFORMATION IN REGARD TO FUNGI AND FUNGICIDES.

Futher information in regard to fungi and more explicit directions in regard to preparing and using fungicides may be obtained by addressing the State Pathologist, Maryland Agricultural Experiment Station, College Park, Md.

SOME IMPORTANT SPRAYING APPARATUS AND OTHER ACCESSORIES.

By Harris P. Gould.

General Remarks.—The spray pumps which were at the command of fruit growers and other horticulturists ten or fifteen years ago would hardly be recognized as the prototype of the apparatus at one's disposal at the present time. While no one pump or piece of apparatus can be said to be perfect, or in other words to embody all the good points, yet the fact remains that spraying apparatus, generally speaking, has been brought to a high degree of perfection, and there are now obtainable at moderate cost almost numberless different styles of pumps and other equipment, any one or part of which would doubtless give satifaction to the user.

We are frequently asked by prospective purchasers for our opinion as to the "best" spray pump. As a matter of fact there is no "best." If a man uses a certain kind of plow or binder and becomes accustomed to it, he will usually like it if it does good work. His neighbor across the way may become used to the implements of some other manufacturer and so for him they are better than any other, because he has learned just how to use them. So it is with spraying apparatus. The individual likes and dislikes of the user will help decide what style of pump is likely to prove most pleasing. What one fruit grower may like another may dislike.

However it is hoped by the writer that the following discussion of spraying apparatus may place before the horticulturists of Maryland and others interested in spraying, information that will help them in selecting equipment for this purpose.

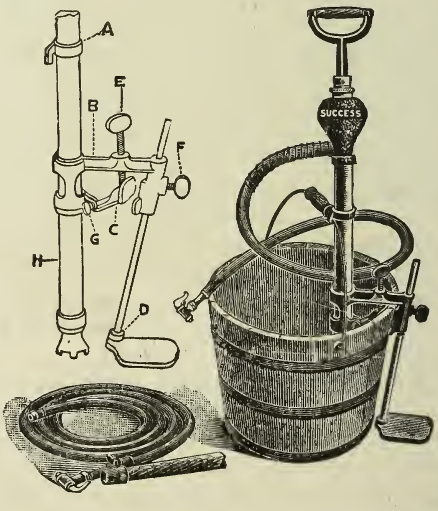

Fig. 14 —A Bucket pump. (The Deming Co.)

WHAT ARE BUCKET PUMPS?

These are small hand pumps intended for spraying liquids from a bucket. As a rule they are so constructed that the pump itself is placed in the bucket; a foot piece is attached which reaches to the ground and by placing the foot on this, the pump is rigidly held in position while it is being worked. They are useful in many ways about the home and garden.

Nearly every spray pump manufacturer makes pumps of this kind. The cost of the various styles ranges from four or five dollars to nine or ten. They may also be obtained of many hardware dealers.

A satisfactory bucket pump is shown in Fig. 14. The device for attaching the pump to the bucket is shown in the portion of the illustration at the left of the bucket.

WHAT ARE KNAPSACK PUMPS?

This style of pump is so called because it is carried on the back in the same manner that a knapsack is. It consists of a tank with a capacity of about three or four gallons, into which is fixed a small pump. The latter is so adjusted that it can be operated with one hand. The pump is provided with a small air chamber that insures a steady spray. The details of construction adopted by the different manufacturers vary more or less but the general plan is much the same in nearly all of them.

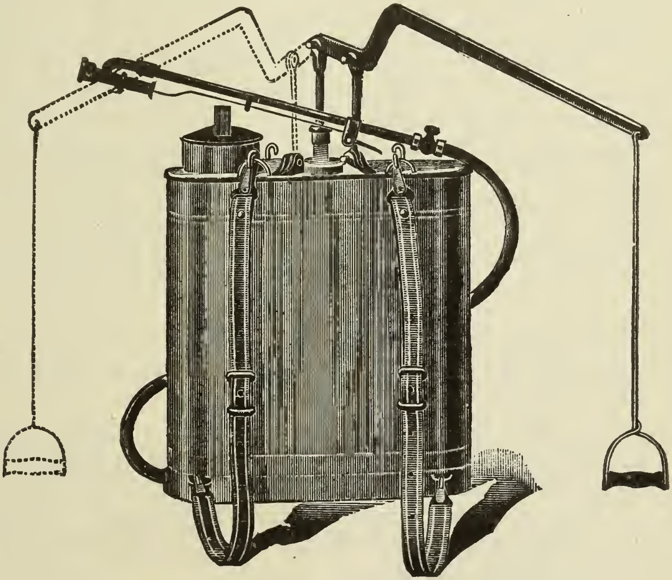

FIG. 15.—Knapsack pump. (The Goulds Manufacturing Co.)

Knapsack pumps are adapted for spraying crops like potatoes, grape vines, and other low growing plants, especially if their habit of growth does not admit of free access with heavier equipment.

A large number of different styles are on the market. The prices range from $10 to $15. A knapsack pump is shown in Fig. 15.

WHAT ARE BARREL PUMPS?

These are pumps intended for mounting on barrels and are without doubt the most important type of spray pump. Nearly all orchard spraying is done with pumps of this class. With proper accessories, they are sufficiently powerful to throw a spray to the tops of all ordinary fruit trees. They are made by a large number of different manufacturers, and while the same principles are involved in nearly all of them the style of construction varies greatly.

On account of the importance of this type of pump, it is well to consider, in connection with this discussion, what the essential features of a good pump are.

The Air Chamber.—This is necessary in order to insure a steady spray; without it the spray would be intermittent. Some of the barrel pumps have air chambers unnecessarily large and the pumps are made thereby more cumbersome and heavy than utility demands. A capacity of about one quart will usually be more satisfactory than if larger. In some styles the air chamber is placed on the pump as a separate attachment but the better method is to combine it with other parts of the pump as is shown in Fig. 18.

Agitators.—Nearly all of the barrel pumps are provided with some kind of an agitator for keeping the spraying mixture stirred while it is being applied. Though the stirring is necessary, the best means of doing it is a debatable point. Manufacturers commonly make sweeping claims for the effectiveness of their devices, and while these may do the work well, it is a question if a narrow strip of board inserted into the barrel through the hole used in filling the latter, is not preferable to any attachment which can be fastened to the pump. The automatic agitator necessarily increases more or less the labor of working the pump, but with the ladel, the man who operates the pump can stir the mixture frequently with but little inconvenience. The essential point, however, is to keep the mixture thoroughly stirred so that it will be applied at a uniform strength. Any means of agitation which will accomplish this, may be considered satisfactory if it does not unduly increase the labor of operating the pump.

The Working Parts.—These are the parts of a pump which are actively concerned in the forcing of the liquid; the valves, plunger, and cylinder are the principle parts referred to.

As many of the spraying mixtures are corrosive in their nature, it is essential that the working parts—those which must fit as closely as possible—be made of some metal not affected in any way by these corrosive materials. Brass is usually employed for this purpose. If iron be used its surface is quickly corroded and the valves and other closely fitting parts made to leak thereby.

Valves.—One of the most important features of a pump is the valves. In the older styles these were usually made of leather or had leather packing, and even in some of the newer patterns leather is used in their construction. Such pumps may work well for a time but the leather quickly becomes stiff and hard and requires frequent replacing. Valves made entirely of brass give the best satisfaction.

General Style.—While the details of construction may be varied greatly, a few points should be considered. A pump should be compact and so made that when mounted on a barrel as little as possible of the pump shall project above the barrel. If too much of the pump extends above the barrel, it becomes top heavy, easily tipped over when empty or nearly so, and low hanging branches are likely to catch the pump while moving from tree to tree in the orchard.

The majority of pumps are attached to the barrel by means of bolts or screws. These soon become rusty and difficult to remove. Consequently some other means of attaching the pump to the barrel is desirable. A few styles are provided with a clamp or some similar contrivance whereby the annoyance of having to remove rusty screws or bolts is reduced to a minimum.

Cast iron handles are easily broken, if a sudden strain is put upon them, consequently malleable iron or something less easily broken than cast iron is preferable for this purpose.

Points of a good Pump.—The points of greatest importance have already been referred to but it may be of convenience if they are brought together under one head.

(1)—The air chamber should be sufficiently large to insure a steady spray and be so placed on the pump that the latter will not be rendered top heavy thereby, nor unduly cumbersome.

(2)—Some means of keeping the spraying mixture thoroughly stirred is essential, but it is not necessary that this be attached to the pump.

(3)—The working parts should all be of brass and be so arranged that they can be examined without undue difficulty.

(4)—The pump when mounted should not extend above the barrel more than is necessary.

(5)—It is desirable to have the device for attaching to the barrel so arranged that the pump can readily be mounted or removed from the barrel.

(6)—The different portions of the pump should be so constructed that they can be readily taken apart, especially those portions which enclose the valves.

(7)—All points for attachment of the hose should be cut with threads of standard size.

Some Specific Styles.—A large number of different makes of barrel spray pumps are now on the market. They differ considerably in the details of construction but it will not be necessary to discuss this phrase of the matter at great length. Two or three illustrations will give the reader an idea of this type of pump.

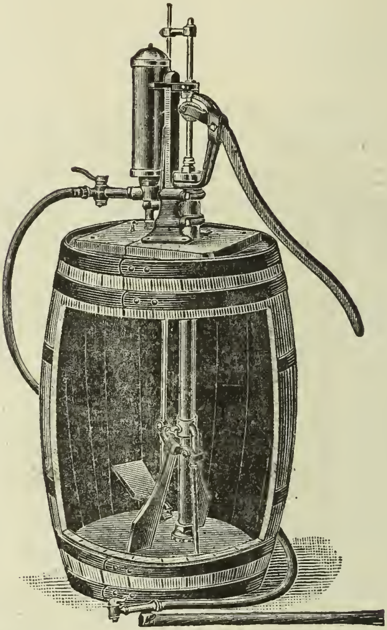

FIG. 16.—The Peerless Pump. (The Deming Co.)

Fig. 16. shows a compact pump of convenient design. While the air chamber is a separate attachment, its moderate size renders this feature unobjectionable. Another style is shown in Fig. 17. The illustration makes the parts sufficiently plain so that no further description is necessary. The cost of this pump is about $8.00. The valves however are not so satisfactory as they are in some other patterns.

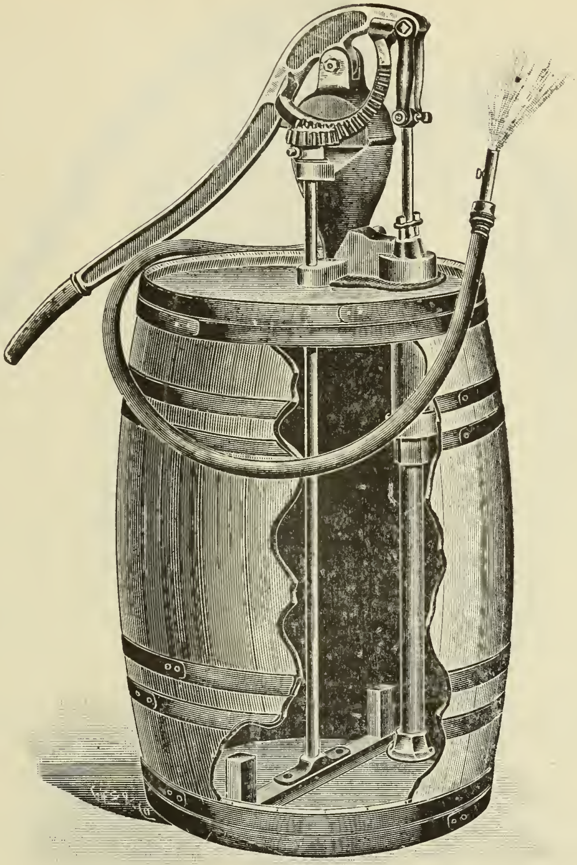

Fig. 17. Empire Queen. (Field Force Pump Co.)

All things considered the design shown in Fig. 18 is one of the most satisfactory now on the market. The air chamber surrounds a tube which extends from the bottom of the pump to the point of discharge. The valves are made entirely of brass and the plunger is a brass cylinder six or eight inches long which works in a pump cylinder made of the same material. It is sometimes necessary to repack the plunger but the construction of the pump renders this a simple and easy matter. This style, pump, only, with working parts of brass costs $15.00. At least three companies manufacture pumps of this same general description.

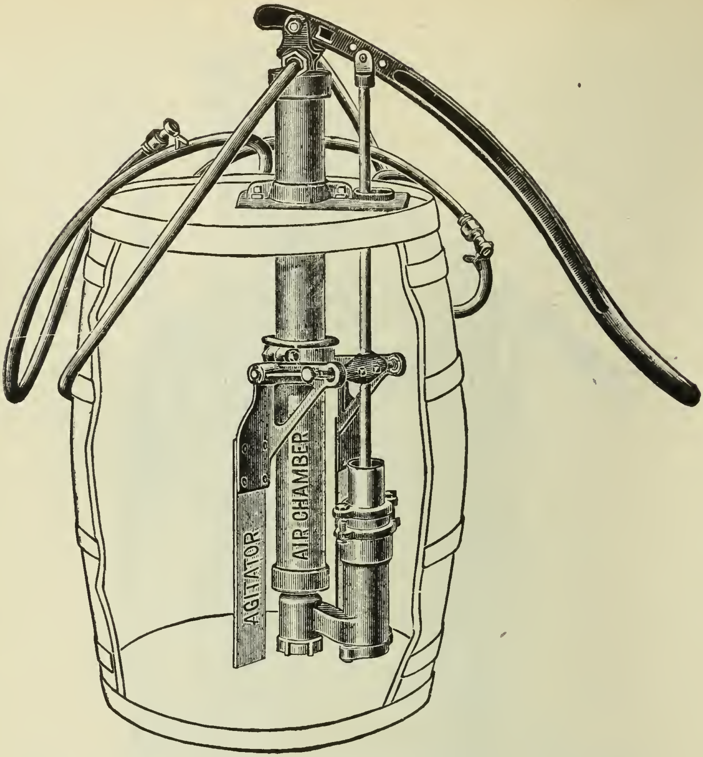

FIG. 18.—The Pomona. (Goulds Manufacturing Company)

WHAT ARE KEROSENE (COAL OIL) PUMPS?

The increased use of kerosene as an insecticide, during the past few years has brought about an increased demand for some means of applying the kerosene which is more satisfactory than in the form of an emulsion. Several manufacturers are now making pumps by means of which a mechanical mixture of kerosene and water, in any desired proportion, can be produced. Of course the oil and water will separate after a time, but the object.of the mixture is in nowise defeated thereby. In fact this mechanical mixture is as permanent as much of the kerosene emulsion which people have been in the habit of using.

These pumps may be had either as bucket pumps, knapsack or barrel sprayers. Two styles with reference to the forcing of the oil, are made In one the oil and water are brought into conjunction with each other by the same pump . The proportion of oil to water is regulated by varying the size of the opening between the oil tank and channel through which the water passes. Fig. 19. Shows a barrel pump of this sort. The cash price of this apparatus varies from $18 to $23.

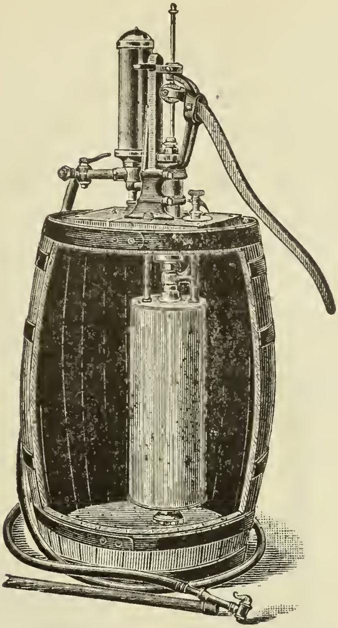

FIG. 19.—A Kerosene pump. (The Deming Company.)

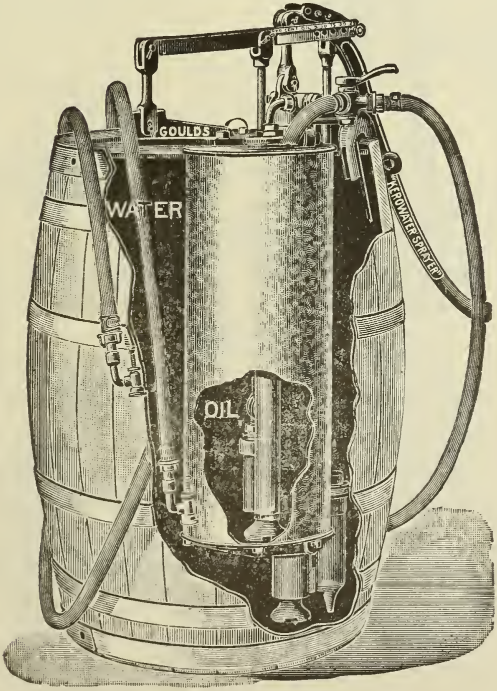

FIG 20.—Another style of Kerosene Pump. (Goulds Mfg Co.)

Fig. 20. shows a kerosene pump in which the oil is worked by an independent pump. The proportions of oil and water are regulated by the relative length of the stroke of the two pistons. The length of the stroke can be regulated to suit the operator. This pump has proven very satisfactory. The pump with or without hose and nozzles costs from $21.00 to $26.50.

WHAT ARE HORIZONTAL PUMPS?

This type of pump, Fig. 21, is well adapted for extensive orchard spraying. It is much more powerful than the ordinary barrel pump and will supply four leads of hose. The extensive fruit grower who has large orchards to spray and plenty of help, with conditions which make it desirable to complete the spraying as soon as possible, will find this type of machine well suited to his needs. The pump is connected with the tank containing the spraying mixture by means of a suction hose which is shown in the illustration. This pump without any accessories may be bought for about $30.00

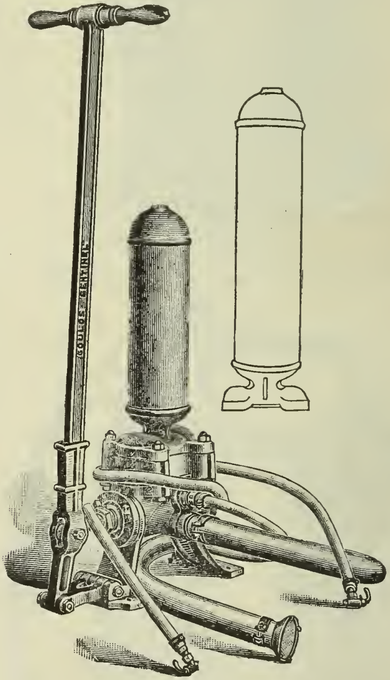

FIG. 21.—The Horizontal type of Spray Pump. (Goulds Mfg Co.)

WHAT CONSTITUTES A GOOD NOZZLE?

A good nozzle is essential for satisfactory work and other things being equal, that nozzle which will throw the finest spray the greatest distance is the best. The finer and more mist-like the spray is the better, but of course, in actual practice, it is impossible to apply the liquid in the form of a mist. Such a spray could be thrown only a very short distance, and it is often necessary to throw it some ways in treating large trees. But whatever the distance it is necessary to have the spray as fine as possible and still place it where it is wanted.

The shape of the spray as it leaves the nozzle is determined largely by the shape of the orifice and the obstructions which the liquid meets before it is entirely clear of the nozzle. For most purposes a fan shape spray is preferable, though for spraying some plants a cone shape one is desired by some. Nearly all the spray pump makers also manufacture nozzles and many different styles are obtainable. It will be well to refer briefly to some of these.

The Vermorel, Fig. 22, is one of the best nozzles for close work and with proper accessories it may be used for distant work as well. The spray which it makes is fine and mist like; it is a cone-shape spray. Several different manufacturers make the Vermorel. It costs from 75 cents to $1.00. For extensive work like the spraying of trees, a combination of Vermorel nozzles like that shown in Fig. 23 is a useful accessory.

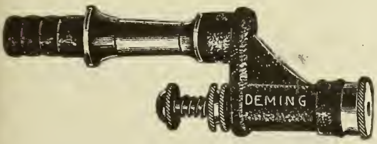

Fig. 22.—The Vermorel Nozzle. (The Deming Co.)

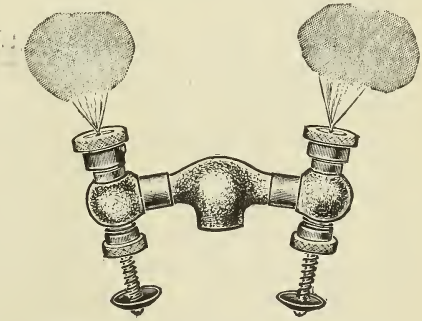

Fig. 23. - Double discharge Vermorel. (The Goulds Mfg. Co)

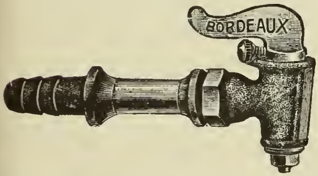

Fig. 24.—The Bordeaux Nozzle. (The Deming Co.)

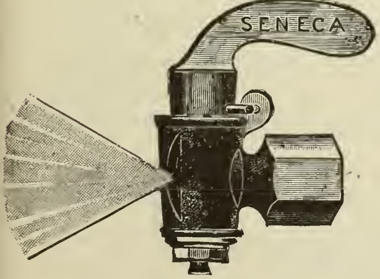

Fig. 25.—The Seneca Nozzle (The Goulds Mfg Co.)

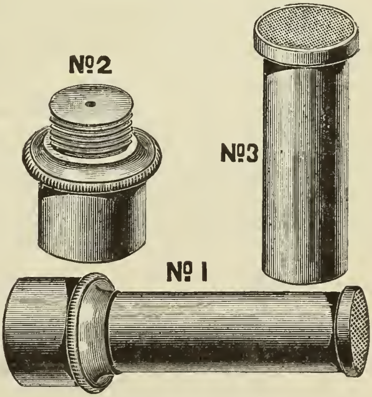

Fig. 26.—The Nixon Nozzle. (Nixon Nozzle and Machine Co.)

Figs. 24 and 25 are nozzles which make a fan shape spray. The size of the orifice through which the liquid passes can be regulated at will, and they are easily cleared if they become clogged. These nozzols cost about the same as the Vermorel.

Fig 26. shows a nozzle of quite a different style from the ones already referred to. After the liquid passes through the orifice (see No. 2.), it strikes against the wire gauze at the outer extremity of No. 3 and is broken up into a spray thereby. The fineness of the spray is regulated largely by the size of the meshes. This style of nozzle has never come into very general use.

For heavy orchard spraying, nozzles that will throw a large quantity of liquids are desirable, though combinations similar to the one referred to are fairly good substitutes. Of the nozzles throwing a larger quantity than any thus far mentioned, the McGowan is one of the most satisfactory. The Gem may also be referred to in this connection.

The cost of nozzles vary considerably but to say from 75 cents to $1.50 will give a fair idea of their value. Combination nozzles cost more. Fig. 23 is listed at $2.00.

WHAT IS A SATISFACTORY KIND OF HOSE?

A good grade of one-half inch hose is generally preferred for spraying purposes. (This has reference to the inside diameter). Some have used a smaller and lighter hose than this but for powerful pumps and hard usage, the heavier hose is probably the more satisfactory. It is economy in the end to get hose of good quality although the first cost is a little more. Its wearing qualities will more than offset the increased expense. Three or four-ply one-half inch hose will cost 15 cents a foot or more. Woven web hose is also satisfactory for spraying purposes.

ARE THERE ANY OTHER USEFUL DEVICES?

A great variety of useful accessories are available for the one who wishes the completest outfit possible and some of these are essential to thorough and expeditious work. Only a few of these can be referred to here.

Extension Rods.—These are small brass rods or brass tubing encased in bamboo poles for attaching to the end of the hose. By putting the nozzle on the outer extremity it can be raised into the top and high branches of the trees. Various lengths from six to twelve feet are obtainable and the cost varies likewise; from $2 to $4 will be conservative limits.

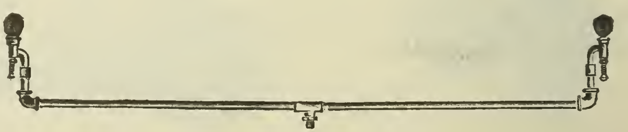

FIG. 27.—Attachment for spraying plants grown in rows.
(The Goulds Mfg. Co.)

Attachments for spraying plants growing in rows.—Figure 27 gives an idea of a simple arrangement for spraying two rows at time. For potatoes and other low growing plants cultivated in rows this is a convenient device. The hose from the pump is attached midway between the extremeties of the extension. This point may be seen in the figure. Extensions similar to Fig. 27 for spraying four rows may be obtained.

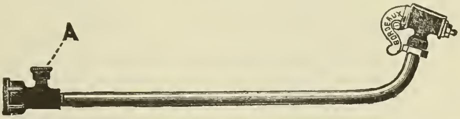

FIG. 28.—A convenient device. (Deming Co).

Device for spraying the under side of leaves.—A simple but important device for this purpose is shown in Fig. 28. The elbow at the outer extremity enables the operator to reach the under side of the foliage with the spray. In spraying for plant lice and other sucking insects this is often necessary.

Arrangement of a wagon for orchard work.—Under some conditions the barrel sprayer may be placed on a stone-boat or simple sled-like arrangement made for the purpose and thus moved about through the orchard, but for ordinary orchard work it is more convenient to put the sprayer in some farm wagon and work from this. The work will be greatly facilitated if a platform is built in the wagon which will raise the man who directs the spray four or five feet or more above the bottom of the wagon. A railing should be put around this platform to prevent danger of the operator falling off if the team starts unexpectedly. With a good extension rod and such an arrangement as this for the wagon it is not difficult to throw the spray to the top of ordinary fruit trees. The platform should be so made that it can be readily removed from the wagon.

WHY DOES A PUMP SOMETIMES FAIL TO WORK?

To the one who is familiar with spray pumps, reference to this matter may be superfluous, but there are many who are at a loss to know what to do when a pump refuses to work properly. Two or three points may be mentioned in this connection.

Sometimes a little sediment becomes lodged under one of the valves, thus causing it to leak. In such a case the pump will not throw its accustomed amount of liquid. Of course the solution of this difficulty is to take the valve out and clean away the obstruction.

A second point and one not infrequently met, is the wearing of the packing which is intended to make the plunger work tightly. If this wears so that the liquid passes up by the plunger, much of the force of the pump is lost, and perhaps, even, the leakage may be so great that no spray whatever can be thrown. In such a case repacking is the remedy.

If a large quantity of lime is used in bordeaux mixture, more or less of it is likely to accumulate in the barrel and clog the strainer at the bottom of the pump. When this happens, if the pump is working as it otherwise should, the handle, upon being raised, will at once be drawn down again with more than usual force.

The operator is sometimes baffled when he first starts the pump, after it has been standing for some time, because it fails to work, although it was working well the last time he used it. This may be due to the valves sticking, perhaps, being cemented in place by the drying of sediment which had collected around the valve when it was used the last time.

There may be other points of difficulty, but these mentioned are the most common sources of annoyance. It is a good plan for the man who gets a new pump, if he possesses ordinary mechanical ability, to take it apart before he uses it and find out just how it is made. By knowing this he can often avoid unnecessary delay and annoyance during the spraying season.

WHAT CARE SHOULD BE GIVEN SPRAYING APPARATUS?

A word in reply to this question may not be out of place. While spraying apparatus may not be more expensive than many other implements which mean even less to the fruit grower than his spraying apparatus does, yet it is too expensive to neglect.

If the apparatus is to be used every day little or no special care is necessary, but when a job of work has been finished and the pump is to stand unused for several days, all of the spraying mixture should be emptied out of the barrel and clear water forced through the pump, hose and nozzle. This washes off the corrosive mixtures and frees the valves and other parts of all sediment which might otherwise dry and cause delay when the pump is wanted the next time.

At the end of the season when the pump is to be stored for the winter, it ought to be removed from the barrel and taken apart so that all foreign substances may be thoroughly cleaned away. By paying a little attention to these matters the period of usefulness of apparatus may be greatly lenghtened over what it would be if no care is given to the equipment.

HOW CAN DRY SUBSTANCES BE APPLIED?

While it is usually preferable to apply insecticides and fungicides in liquid form, it is sometimes convenient to use a powder. Several styles of machines for this purpose may be obtained. Perhaps one of the best of the inexpensive forms is that in which a receptical for containing powder is so attached to a small hand bellows that by working the latter the powder is driven out in small quantities. These may be obtained of seedsmen, hardware dealers and others for from $1.00 to $2.00.

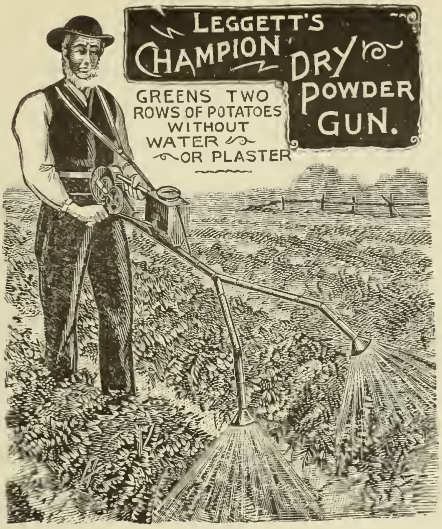
LEGGETT'S
CHAMPION DRY POWDER GUN.
GREENS TWO ROWS OF POTATOES WITHOUT WATER OR PLASTER

Fig. 29.—Apparatus for applying powders. (Leggett Bros.)

Figure 29 shows a good powder gun. The illustration is self-explained. The cost is about $6.00

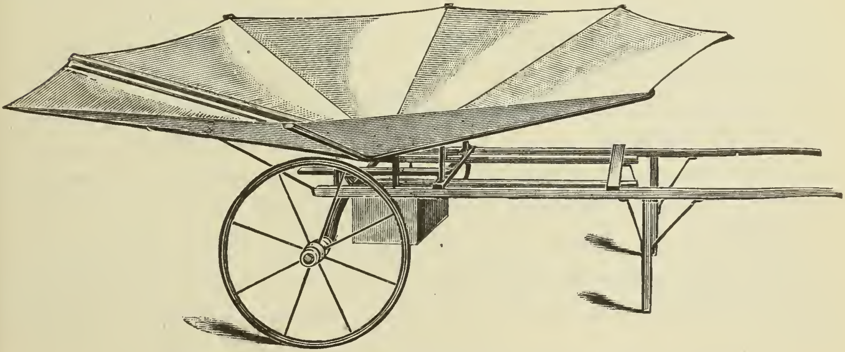

Fig. 30.—Curculio Machine (J. B. Johnson).

The Curculio Machine.—This is shown in Fig. 30. It is an inverted umbrella shaped device mounted on wheels and so arranged that when put in position, the trunk of the tree is at the center of the apparatus. A small tank is attached to the lowest point of the machine into which the curculio are brushed from time to time by the operator. A small quantity of kerosene should be put into the tank to prevent the insects from escaping. After placing the machine in position under the tree, the limbs should be jarred by tapping them with a padded stick. If done early in the day, the curculio readily fall from the trees. The machine costs about $15.00

WHAT PUMP WOULD YOU RECOMMEND?

In our official work, we represent no manufacturers and we do not call attention to any make or style of pump for the purpose of advertising it. But we are frequently asked by those who are becoming interested in spraying apparatus, to recommend pumps to them. In doing so we merely put a pump on its own merits and usually speak from our own experience with spraying apparatus, though of course we cannot try them all.

The catalogues of most manufacturers are well illustrated and it is wise for those who have had no experience with spraying apparatus, to secure several of these and carefully look them over before selecting a pump. To this end, the following list of manufacturers is given;

Field Force Pump Co.,	Lockport, N. Y.
John J. McGowan,	Ithaca, N. Y.
W. & B. Douglas,	Middletown, Conn.
The Goulds Mfg. Co	Seneca Falls, N. Y.
Morrill and Morley	Benton Harbor, Mich.
The Caswell Sprayer Co.,	Sandusky, Ohio.
The Deming Co.,	Salem, Ohio.
Thos. Pepper	Highstown, N. J.
P. C. Lewis Mfg. Co.,	Catskill, N. Y.
Rumsey and Co.,	Seneca Falls, N. Y.
Wm. Stahl	Quincy, Ill.
Leggett and Bro	New York, N. Y.
Bean-Chamberlain Mfg. Co.,	Hudson, Mich.
F. E. Myers and Bro	Ashland, Ohio.
Nixon Nozzle and Machine Co.,	Dayton, Ohio.
J. B. Johnson	Geneva, N. Y.

Spray pumps and materials can generally be procured through the local dealers in agricultural implements and supplies.

The materials mentioned in this bulletin for use as insecticides and fungicides can be procured generally of local dealers in agricultural supplies, but the following firms in Baltimore make a specialty of handling them;—

Baugh & Sons Company,	412 Exchange Place
Griffith and Turner Co.,	205 North Paca St.
Hanline Bros.,	23 South Howard St.
Powell Fertilizer & Chemical Co	306 Water St.
Theo. Smith,	800 West Baltimore St.
Thomas & Thompson,	Cor. Baltimore and Light Sts.

It has been considered advisable not to give prices on these materials, since there is more or less fluctuation from time to time and the price also varies with the quantity of material purchased. It is suggested that persons desiring any of the insecticides or fungicides write to dealers and procure quotations before purchasing.

SPRAY CALENDAR AND OTHER SUGGESTIONS.

Only the most important insects and diseases, those which may be expected to occur every year, are considered in this brief outline. The treatment here recommended should be considered as an *insurance* of the crop or a *preventive* against the ravages of disease and insects rather than a cure for the same. In following these directions many lesser pests will also be controlled aside from those specifically mentioned.

Note.—When Paris green* is mentioned it should be understood that the application intended is at the rate of 1 pound to 150 to 200 gallons or for general spraying 1 pound to 160 gallons. Whenever it is advised to use Paris green and Bordeaux mixture at the same time, they may be applied together, the latter being put in the Bordeaux instead of water. The figures of the text refer to the number of the application. If an application is immediately followed by a rain sufficient to wash off the mixture, it should be repeated. Applications in parenthesis are least important and may be omitted if in the judgment of the operator they are unnecessary.

*London purple arsenate of lead or green arsenoid can be substituted for the Paris green. See page 57.

APPLE.

DISEASES—*Scab.*—1. [Bordeaux just as leaf buds begin to expand]. 2. Bordeax when leaves are fully expanded but before blossoms open. 3. repeat 2 immediately after falling of blossoms. 4. Repeat 2 in about two weeks. 5. Repeat if necessary. *Rust.*—Same as for scab, 2d and 3d being of greatest importance. As one stage of the disease is passed on cedar trees, the removal of these, where practicable, will prevent its spread. INSECTS—*Codling moth.* 1. Paris green in Bordeaux immediately after blossoms fall (see page 58). Repeat within a week to 12 days according to weather, and before the fruit turns calyx end downwards. 3. Keep fallen fruit picked up. *Canker Worm. Tent Catapillar.* Paris green as soon as insects appear; can usually be applied with Bordeaux. 2. Repeat in four or five days if insects still remain. *Bud Moth, Case Bearer.* 1. Paris green as soon as tips of expanding leaf buds apppear. 2. Repeat 1 before blossom buds open. *Borers.* These cannot be controled by spraying. The trees, especially young orchards should be frequently examined during the summer and the borers dug out.

ASPARAGUS.

DISEASES.—*Rust, Leopard Spot.* These diseases are difficult to control. Keeping the growth well sprayed with Bordeaux after cutting ceases and mowing the tops and burning in the fall are recommended. INSECTS—*Asparagus Beetle.* Allowing a series of "trap plants" to grow during the cutting period and destroying some of them every week will probably reduce the damage somewhat. Spraying old beds with Paris green or dusting them with land plaster and Paris green when dew is on, after the cutting season is over, will also check the pest. Spraying young plants with Paris green in water when the larvae appear or dusting with land plaster and Paris green is recommended (see page 58). Jarring or sweeping (with broom-like brush) the larvae from the young plants during midday in hot sun, is recommended. In sandy soil many larvae are destroyed in this manner.

CABBAGE AND CAULIFLOWER.

DISEASES—*Club-foot.* Rotation of crops. Do not grow cabbage or similar plants on infested soil for two or three years. INSECTS. *Cabbage-worm, Plusia.* Use Paris green, either dry or in water; the dry method is preferable,[see page 58] whenever insects appear in destructive numbers until heads are half grown. If latter applications are necessary, use hellebore [see page 62] *Harlequin or terrapin bug.* The sowing of kale as a trap-plant, between the rows or about the field is suggested. Hand picking. Kerosene emulsion to destroy young bugs [see page 60]. Paris green will not destroy these insects.

CELERY.

DISEASES—*Blight.* 1. Bordeaux or Ammoniacal solution of copper carbonate as soon as plants become well established. 2, 3, etc. Repeat 1 every week or often enough to keep foliage well covered, until danger of disease is past. INSECTS—*Celery caterpillar.* Paris green as soon as insect appears, especially while plants are young.

CHERRY.

DISEASES—*Black-knot.* 1. As soon as discovered cut off affected parts, if on small limbs eight or ten inches below the point of infection, and burn. 2. Frequent applications of Bordeaux after cutting out will have a tendency to check the spread of the disease. *Fruit-Rot.* 1. When leaf buds are opening, Bordeaux. 2. Repeat 1 when fruit has set. 3. Ammoniacal solution of copper carbonate in a week or ten days after 2 [to avoid staining fruit]. 4. Repeat 3 every week if weather is hot and muggy. INSECTS—*Slug.* 1. Paris green as soon as insects appear, or dust insects with air slacked lime or even road dust. 2. Repeat 1. in three or four days if insects still persist. One pound whale oil soap in four to five gallons water, or hellebore [see page 62].

CUCUMBER, CANTALOUPE AND SQUASH.

DISEASES—*Blight, Mildew.* 1 Bordeaux mixture as soon as plants become well established. 2. Repeat 1 often enough to keep vines well covered with Bordeaux until danger of diseases is past. INSECTS—*Striped Cucumber Beetle, Squash bug.* Plants covered with Bordeaux are seldom seriously troubled. This merely drives the insect away. It must be applied as soon as plants are out of the ground. Dusting the plants with air-slaked lime, ashes or soot is also recommended. *Melon plant louse.* Kerosene mixture or kerosene emulsion [see page 60]. The destruction of badly infested plants.

CURRANT.

DISEASES—*Blight.* 1. Bordeaux as soon as fruit has set. 2. Repeat 1 in ten to fifteen days. 3. Ammoniacal solution copper carbonate when fruit is reaching full size. 4. Bordeaux after fruit has been picked. INSECTS—*Currant worm.* 1. Paris green, dry application [page 58] as soon as insects appear. 2. Repeat 1. within a week if necessary. 3. If insects reappear after fruit is half grown, use hellebore [see page 62].

EGGPLANT.

DISEASES,—*Leaf-spot.* 1. Bordeaux as soon as plants are fairly established in field. 2, 3, Repeat every two or three weeks until fruit is half grown. 4. Ammoniacal copper carbonate solution to avoid staining fruit. Repeat when necessary. INSECTS—*Potato bug* and *Flea beetle.* 1. Paris green, dry method, as soon as insects appear. 2. Repeat when necessary.

GOOSEBERRY.

DISEASES—*Mildew.* 1. Bordeaux as soon as growth begins. 2. Potassium sulfid when leaves are expanded. 3. 4, etc. Repeat 2 every ten or twelve days until danger is past. INSECTS—*Currant worm.* See under Currant.

GRAPE.

DISEASES—*Anthracnose.* 1. Sulfate of iron and sulfuric acid solution before buds break in spring. 2. Repeat 1 in a few days if untreated portions of vines are detected. *Black Rot.* 1. [Bordeaux as soon as first leaves are expanded]. 2. After fruit has set, Bordeaux. 3. Repeat 2 often enough to keep foliage well covered with Bordeaux until fruit is three fourths grown. Ammoniacal solution of copper carbonate when fruit is nearly grown. 5, 6, etc. Repeat 4 every two weeks or so until near harvest. *Downy Mildew, Powdery Mildew.* Same as for Black-Rot, except that first application is important. *Ripe-Rot.* Later applications under *Black Rot* are important. INSECTS—*Grape-vine Flea beetle.* 1. Paris green in solution, [page 58] very thoroughly applied as buds are swelling. 2. Repeat 1 in a few days if necessary. 3. When larvæ appear on leaves dust on air slacked lime, or spray with Paris green. Hellebore can be used also [see page 62].

PEACH.

DISEASES—*Brown Rot.* 1. Before buds swell, copper sulfate solution or Bordeaux. 2. Bordeaux after fruit has set. 3. Repeat 2 every ten or fourteen days until fruit is nearly grown. 4. Ammoniacal solution copper carbonate after fruit is nearly grown. 5, 6, etc. Repeat 4 as often as necessary until fruit is picked. *Fruit Spot.* Same as for *Brown Rot*, except that first application may be omitted. *Leaf.Curl.* 1. Bordeaux after buds swell. 2, 3, Repeat 1 at intervals of ten days or so. The first two applications most important. *Yellows.* Dig up and burn infested trees. INSECTS—*Borer.* Dig out the worm late in the fall, and mound earth about the trunk of tree. *Curculio.* Spraying is not effective. Jar the trees after fruit has set every day or so for two or three weeks, or until no more insects are found. A Curculio catcher [see page 83] should be used; the insects collected and killed.

PEAR.

DISEASES—*Twig-Blight.* Cut off affected twigs ten or twelve inches below affected part as soon as discovered and burn. *Scab.* See under *Apple. Leaf-blight, Leaf-Spot.* Same as for *Scab.* INSECTS—*Pear leaf blister* mite. Before buds start in spring, kerosene diluted 10 to 12 times.

Burning the branches after pruning will also lessen the number. *Psylla.* 1. Kerosene diluted 12 to 15 times, as soon as leaves have unfolded. 2, 3, etc. Repeat 1 every two or three days if necessary. *Slug.* See under. *Cherry Codling-moth.* See under *Apple.*

PEAS.

INSECTS—*Destructive Green Pea Louse.* Kerosene diluted 10 to 12 times with water, [see page 70]. Air slaked lime or tobacco dust when vines are damp.Paris green has no effect upon this insect. Destruction of volunteer and very late peas.

PLUM.

DISEASES—*Brown-rot.* See under *Peach. Shot-hole fungus.* 1. Bordeaux as soon as leaves have unfolded. 2, 3, etc, Repeat 1 every ten or 15 days until fruit is three-fourths grown. 4. Ammoniacal solution of copper carbonate after fruit is nearly grown. *Black-knot.* See under *Cherry.* INSECTS—*Curculio.* Use the Curculio catcher and jar the trees regularly [see page 83 Fig. 30].

POTATO.

DISEASES—*Early Blight.* 1. Bordeaux when tops one-half or two-thirds grown. 2, 3, etc. Repeat 1 three or four times at intervals of about 10 days. *Late Blight* or *Rot.* 1. Bordeaux about the middle of July, 2, 3, etc. Repeat 1 four or five times at intervals of about 10 days. *Scab.* 1. Avoid planting potatoes on soil known to be infested with the disease. 2. If seed is scabby, soak for one and one half hours in solution of corrosive sublimate, using one ounce of sublimate to eight gallons of water. INSECTS—*Potato Bug.* Paris green either dry or with Bordeaux as soon as insects appear. 2. Repeat 1 if necessary. *Potato stalk Weevil.* Burn all vines in infested fields. Insect lives over winter in the hollow of the vines.

QUINCE.

DISEASES—*Leaf-blight* or *fruit-spot.* 1. Bordeaux as soon as blossom buds appear. 2. When fruit has set repeat 1. 3. Repeat 1 at intervals of two weeks or so, until fruit is nearly grown. 4. If later applications are necessary, use ammoniacal solution of copper carbonate to avoid staining the fruit. INSECTS—*Curculio.* See under *Plum.* [Use the Curculio catcher, see page 83]

RASPBERRY, BLACKBERRY AND DEWBERRIES.

DISEASE—*Anthracnose.* 1. Copper sulfate solution before growth begins. 2. Bordeaux after growth commences. 3. Repeat 2 every ten days or so until fruit approaches maturity. 4. Ammoniacal solution copper carbonate to avoid staining fruit. 5. After fruiting, Bordeaux on young cones, at intervals of two or three weeks throughout the season. Apply to canes as well as to foliage. Cut out and burn diseased canes. *Orange rust.* Dig up and burn all diseased plants. INSECTS—*RoseScale.* Cut and burn infested canes, and spray in May with 10 to 12 per cent kerosene [see page 60].

STRAWBERRY.

DISEASES—*Leaf-blight* or *rust.* 1. Bordeaux as soon as growth begins. 2. Repeat 1 in about two weeks. 3. Ammoniacal solution of copper carbonate after fruit has set. 4, 5, etc After fruit is picked, Bordeaux every two or three weeks throughout the season. New beds, Bordeaux every two or three weeks throughout the season after plants become well established. *Mildew.* 1. Potassium sulfid as soon as growth begins. 2, 3, etc. Repeat 1 every week or ten days until fruit approaches maturity. An occasional application after fruit is picked, if necessary. INSECTS—*Root louse* or *aphis.* Tobacco dust around plants. Plow down badly infested fields. *Leaf-roller, slug, etc.* Paris green in Bordeaux as soon as first insects appear. *Weevil.* No satisfactory remedy known.

TOMATO.

DISEASES—*Blight.* 1. Bordeaux mixture once or more while in seed bed. (This is very important) 2. Repeat 1 as soon as plants are well established in the field. 3, 4, etc. Repeat every ten or fifteen days until fruit approaches maturity. INSECTS—*Tomato worms.* Use Paris green in Bordeaux. Hand picking—*Old fashioned Potato Bug,* Paris green. They can be driven out of a field with a broom or brush.

GENERAL RECOMMENDATION.

Several insects infest a great variety of host-plants and so have not been mentioned in the foregoing recommendation. The ones mentioned below may be treated as described, wherever found.

Aphids or *Plant Lice.* As soon as the insects appear in destructive numbers spray with kerosene diluted 10 to 12 times or some other insecticide which kills by contact: such as soap solutions, tobacco decoctions, tobacco dust or insect powder [see page 60].

San Jose scale and *other scale insects.* Treat with 20 per cent or 25 per cent mechanical mixture of kerosene and water, or whale oil soap, two pounds to a gallon of water. The 25 per cent must be applied when the trees are dormant. Though the 20 per cent solution may be applied when the trees are in foliage, it is best to treat them during their dormant condition. Kerosene [page 60] should be applied on a bright, sunny day. Crude petroleum can also be used [page 62]. For the destruction of insects in stored grain, use Bisulfid of Carbon. For its preparation and application [see page 63].

Insects in mills and elevators, use hydrocyanic acid gas; but consult us before applying it, and get specific directions [see page 63].

Cockroaches can be destroyed by mixing one part of plaster of Paris and three to four parts of flour together, placing it in plates where the insect can get at it. Near by set a plate or pan containing water, so that the insects can drink freely.

It is well to supply several bridges from the flour-plaster to the water by means of narrow strips of light boards. The insects eat the material, then drink the water, after which the plaster sets and clogs their intestines, thus killing them. It is a simple and effective remedy.

PUBLICATIONS

OF THE

MARYLAND AGRICULTURAL EXPERIMENT STATION.

These bulletins are sent free of charge to any address upon application to the Director of Experiment Station, College Park, Maryland.

Only the bulletins named below are available for distribution.

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“	“	6, Sept.,	1889,	Commercial Fertilizers.
“	“	12, March,	1891,	Pig Feeding.
“	“	22, Sept.,	1893,	Steer Feeding; A Well Balanced vs. A Poorly Balanced Ration.
“	“	24, Feb.,	1894,	Composition of Commercial Fertilizers sold in this State.
“	“	26, June,	1894,	Tobacco.
“	“	29, Dec.,	1894,	Further Investigation on the Soils of Maryland
“	“	31, March,	1895,	Potato Experiments.
“	“	32, April.	1895,	The San Jose Scale.
“	“	33, April,	1895,	Horticultural and Agricultural Departments; Small Fruits, Vegetables and Field Corn.
“	“	34, July,	1895,	Composition of Commercial Fertilizers sold in this State.
“	“	35, Sept.,	1895,	Wheat, Barley, Oats and Hay Experiments.
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“	“	37, Feb.,	1896,	Composition of Commercial Fertilizers sold in this State.
“	“	38, March,	1896,	Potato Experiments.
“	“	39, April,	1896,	Spray Calendar.
“	“	40, Aug.,	1896,	Composition of Commercial Fertilizers sold in this State.
“	“	41, Sept.,	1896,	Test of Methods of Preparing and Feeding Corn Fodder
“	“	42, Oct.,	1896,	The Maryland Trees and Nursery Stock Law and Other Information of Special interest to Nurserymen and Fruit growers.
“	“	43, Dec.,	1896,	Report upon the Value of a New Corn Product.
“	“	46, March,	1897,	Corn and Potato Experiments.
“	“	47, June,	1897,	Dairy Farming.
“	“	48, June,	1897,	Some Common Injurious Plant Lice with Suggestions for their Destruction.
“	“	49, Aug.,	1897,	Composition of Commercial Fertilizers sold in this State.
“	“	50, Sept.,	1897,	Rust and Leopard Spot, Two Dangerous Diseases of Asparagus.
“	“	51, Dec.,	1897,	Horse-Feeding; Tests of the Digestibility of Oats, Corn, Hay and the New Corn Product.
“	“	52, Feb.,	1898,	Composition of Commercial Fertilizers sold in this State.
“	“	53, March,	1898,	Special Investigation of the So-called “New” Horse Disease in Maryland.
“	“	54, March,	1898,	Tomatoes.
“	“	55, May,	1898,	The Black peach Aphis, Cut Worms in Young Tobacco—Law Providing for the Suppression and Control of Insect Pests and plant Diseases in Maryland.
“	“	56, June,	1898,	Wheat, Winter Oats, Barley and Lime Experiments.
“	“	57, Aug.,	1898,	The San Jose Scale in Maryland.
“	“	58, Aug.,	1898,	The Hessian Fly and Wheat Diseases.
“	“	59, Jan.,	1899,	Sweet potato Insects.
“	“	60, March,	1899,	Some Diseases of Sweet-potato.
“	“	61, June,	1899,	The Sugar Beet in Maryland.
“	“	62, June,	1899,	Experiments with Wheat, Corn and potatoes.
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“	“	64 Jan.	1900,	A Study of the Cause of Mottled Butter.

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BULLETIN NO. 66
OF THE
MARYLAND AGRICULTURAL
EXPERIMENT STATION,
COLLEGE PARK, MD.,

May, 1900.

THE
Maryland Agricultural Experiment Station.

CORPORATION.

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Guy L. Stewart, B. S.	*Assistant Pathologist.*
Harris P. Gould, M. S. Ag.	*Assistant Entomologist.*
T. M. Price, B. S.	*Assistant Chemist.*
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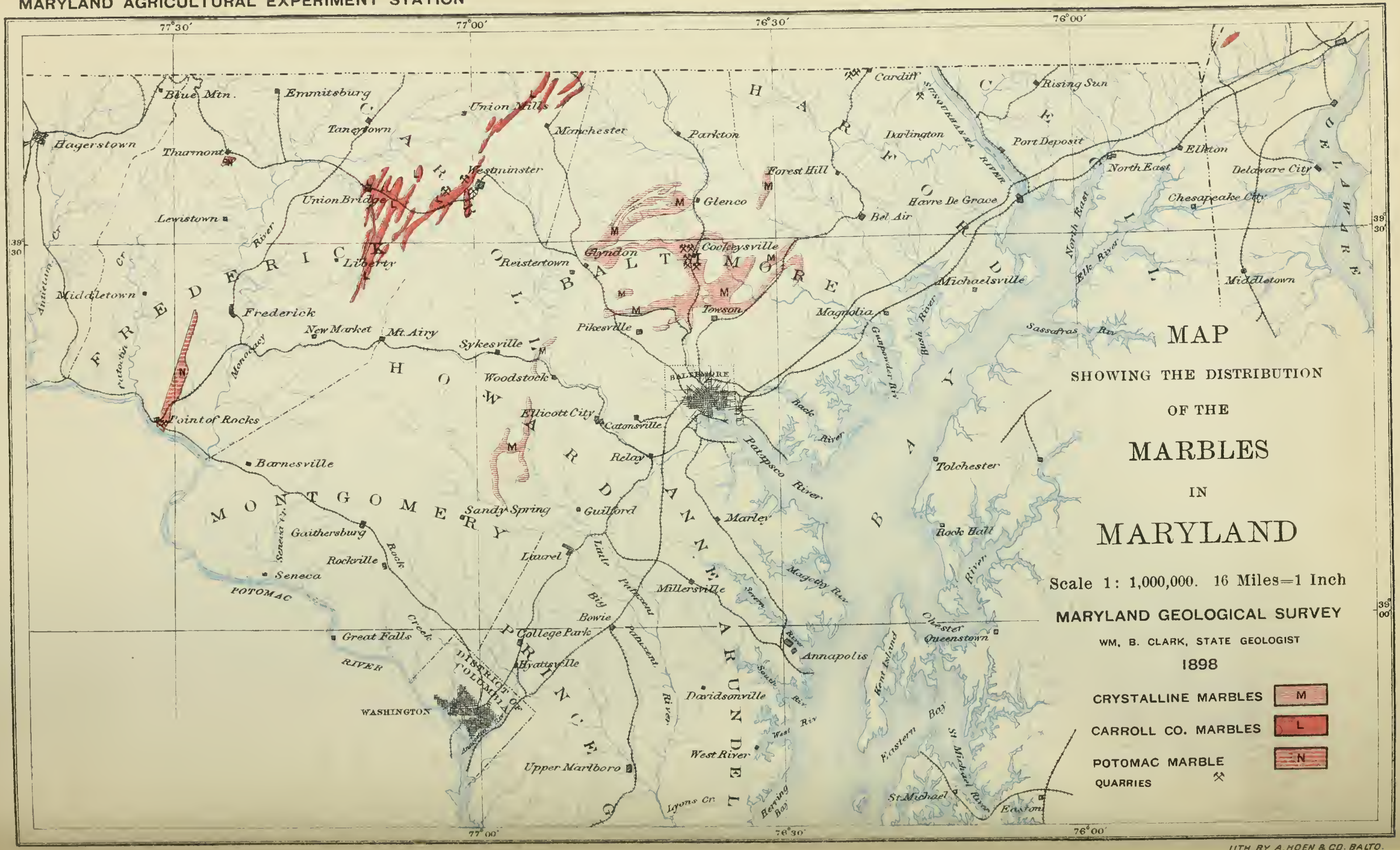

MAP

SHOWING THE DISTRIBUTION

OF THE

MARBLES

IN

MARYLAND

Scale 1: 1,000,000. 16 Miles=1 Inch

MARYLAND GEOLOGICAL SURVEY

WM. B. CLARK, STATE GEOLOGIST

1898

CRYSTALLINE MARBLES	M
CARROLL CO. MARBLES	L
POTOMAC MARBLE	N
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THE MARYLAND
AGRICULTURAL EXPERIMENT STATION.

BULLETIN NO. 66. MAY 1900.

The Occurrence and Composition of Lime in Maryland, Together with a Report of the Results of Experiments in Testing Its Use in Agriculture.

BY H. J. PATTERSON, DIRECTOR AND CHEMIST.

PREFACE.

The matter contained in this bulletin is based chiefly upon the results of investigations conducted at this Station as to the composition and sources of lime in Maryland available for agricultural purposes, and of the results obtained from the series of field experiments conducted during the past twelve years with different forms of lime; also the quantities and methods of applying the same. Some of these results have been reported from time to time in the regular publications of the Station, but the bulk of this matter is presented now for the first time.

We are indebted to Prof. Wm. B. Clark, State Geologist, for the samples of lime-stone representing the various Geological formations and deposits in the State. The chemical analysis of most of these samples was made by Mr. Thomas Malcolm Price, Assistant Chemist of the Station.

GENERAL DISCUSSION OF THE RELATION OF LIME TO AGRICULTURE.

Lime was one of the earliest materials used for improving the productiveness of the soil, as is evidenced by the writings of Pliny and Cato. It was used in this way probably two or three hundred years B. C. That chalk and marl were quite extensively used at an early period in Southern Europe is shown by the notes of Varro, taken during the march of his army to the Rhine. The contributions of Ruffin in the "American Farmer" as early as 1818, show that the agricultural use of certain forms of lime took a prominent place in the agriculture of the United States early in its history.

Although lime was thus used early in the history of agriculture, and has been used to a greater or less degree in all parts of the agricultural world ever since, yet the nature of its action on the soil is but little understood and has been but slightly studied. Almost every one recognizes the fact that there is a great difference in the action of lime on soils of different characters. That there is a difference between the action of limes of different character and composition on the same soil is a point seldom noticed.

The term *"lime"* is generally understood to mean quick or caustic lime or Calcium Oxide (CaO). When any form of carbonate of lime; lime-stone, oyster shells, or shell marl, is burned, the carbonic acid is expelled and lime or quick lime is produced. In burning, the Calcium (lime) carbonate ($CaCO_3$) undergoes decomposition, carbonic acid being thrown off, and caustic quick-lime (Calcium Oxide, CaO) remaining in the kiln. The fuel generally used in burning lime is wood, charcoal, coal or coke, and the ashes from these will be found as impurities in the lime.

The kiln may consist of only a crude pile of logs, and wood so arranged as to admit the air and burn freely with the stone or shells piled inside and on top. They may vary in form and construction, all the way from this crude type to those constructed of extensive and solid masonry or steel boiler plate lined on the inside with fire-brick, and so arranged that lime may be perpetually drawn from the bottom while the stone and fuel are being fed at the top. While the types, sizes and details now in use vary considerably, yet the general form most approved is not very different from the description given by Cato. Some limes are burned in retorts, pots or crucibles, thus giving a pure lime, free from the contamination of ashes and unburned fuel.

Lime Burning:—Lime-stone or any carbonate of lime begins to decompose at about 300° C., and the temperature usually employed is indicated by a bright red heat. It ought not to exceed 1100°C, The facility with which lime is burned depends upon the porosity and composition of the stone, the size of the lumps and the volume of air passed through the burning mass. Again the expulsion of carbonic acid is facilitated by the introduction of steam into the mass. This is accomplished by practical lime burners by watering lime-stone which has become dry by standing in the open air.

About one bushel of coal is required to make five or six bushels of lime, but dolomitic (Magnesium) lime-stones require less. If much argellaceous matter is present the lime-stone more readily fuses, and in such cases, great care should be exercised to keep the temperature below the melting point, otherwise the mass vitrifies and the lime resulting is said to be "dead burnt" or "over burnt." "Over burning" may also be due to the forming of a half-burnt lime by a strong and sudden ignition, or by means of high temperatures the silica and alumina, contained in the lime-stone, will become sintered over the surface of the lime, forming a slag or glass which prevents its coming in contact with the water and slacking.

From this it will be seen that the same conditions and heats can not be applied to all classes of lime-stones, and that it is necessary to take extra precautions when burning lime-stone of irregular character and composition. In fact it is well not to attempt to burn different veins of lime-stone in the same kiln at the same time. If it is desired to market different grades or veins of lime-stone, and at the same time place only one grade of lime on the market, these should be burned separately and combined after burning. Such a process, if carefully carried out, would prevent much of the trouble in lime slacking unevenly. It is well to have dampers in the kilns, to put the heat better under control.

In burning, lime-stone retains practically the same volume, but loses about 44 per cent in weight; that is 100 pounds of stone yields about 56 pounds of lime.

Characteristics of Lime:—It is common to hear the terms "Agricultural lime" and "Building lime," used as if these were different articles. In reality, no such difference exists: they are simply trade terms; as the same lime is generally used indiscriminately for the two different purposes. Sometimes, however, the name "Agricultural lime" is used to mean building lime that has been air or water slacked, and again it refers to the quality of the stone from which it was derived. If it were always thus used the term would have a distinct meaning. Unfortunately it is impossible to define or distinguish a building or agricultural lime even from a chemical standpoint, owing to the fact already stated that different soils respond differently to the same lime and *vice versa*. According to the nature of the lime-stone, it will turn out (a) a fat or rich lime; (b) a poor lime; or (c) an hydraulic lime. If lime-stone consists simply of pure Carbonate of Lime, then the lime obtained therefrom will slack readily, forming a creamy mixture with water, and is called fat or rich lime. On the other hand if the lime-stone contains Magnesia it slacks more slowly, forming a thin, poor mixture and is called a poor lime. With ten per cent (10 per cent) of Magnesia a lime is poor, and with twenty-five to thirty per cent it is almost useless. If the lime-stone contains more than ten per cent of silica the lime therefrom will have the quality of forming a paste, which will harden under water or in most places where it is not exposed to the drying influence of the air; such lime is known as hydraulic lime. It is very reasonable to suppose that the different limes act differently on the same soil or on soils of different characters, and much in the same manner as they do in forming mortars and cements.

KINDS OF LIME USED IN AGRICULTURE.

Stone Lime.—Good lime-stone contains from 50 to 55 per cent lime (CaO), and 40 to 45 per cent Calcium (lime) Carbonate, with small amounts of Magnesia, silica, iron and aluminia. Such lime, when burnt, would produce the best quality of caustic or quick-lime, and would contain from 90 to 98 per cent of Calcium Oxide (ÇaO). Freshly burned lime, when removed from the kiln, will weigh about 90 or 95 pounds to the heaped bushel, and will slack about three bushels for one in volume.

Magnesia Stone Lime:—Magnesia lime-stone, or dolomites are quite varied in their composition, and may range in Carbonate of Lime from 20 to 80 per cent, and in Carbonate of Magnesium from 10 to 60 per cent. The average of such lime-stones used in agriculture, when burned, will produce a lime containing from 70 to 85 per cent of Calcium Oxide and 5 to 20 per cent of Magnesium Oxide. Magnesia lime weighs about 75 to 85 pounds to the heaped bushel, and will slack about two bushels for one, by volume.

Oyster Shell Lime:—Oyster shells contain from 90 to 95 per cent of Calcium (lime) Carbonate, and will produce, when burned, a comparatively pure lime, which should contain from 85 to 95 per cent of pure Calcium Oxide if it has not been excessively contaminated with the ashes from the fuel in burning. Freshly burned Oyster shell lime weighs about 60 pounds per bushel, and will slake out a little better than two for one by volume.

Slaked Lime:—In the process of slaking lime it takes up water and forms Calcium or Lime Hydrate. It also absorbs some Carbonic Acid from the air and forms Carbonate of Lime. If different samples of lime or slaked lime are in equally good condition they may be thus compared:—

Kind of Lime.	Wt. per bu. before slaking.	Total Wt. after slaking.	Number Bu. after slaking.	Wt. per Bu. after slaking.
Good stone lime	93 lbs.	135	3	45
Magnesia stone lime	80 "	110	2	55
Oyster shell lime	60 "	100	2½	40

Gas House Lime or Gas Lime:—Quick lime is used at the gas works for removing the impurities of the gas. After it has been saturated with the impurities, and no longer fit for use in gas making, it is sold for agricultural purposes under the name of gas-lime. This article varies considerably in composition, but consists essentially of the hydrate, carbonate, sulphate, sulphides and sulphites of lime. The sulphides and sulphites of lime are injurious to germinating seeds or young and tender plants, so that gas lime should be applied cautiously and when not too fresh. The action of the air on sulphides and sulphites changes them to sulphate of lime (gypsum or land-plaster); hence the exposure of gas-lime to the weather for some time improves its agricultural qualities. Average gas-lime contains about 22 per cent water, 43 per cent lime (CaO), 21 per cent Sulphuric Acid (Oil of Vitriol), 8 per cent Magnesia, and 6 per cent insoluble matter. Of course this will vary considerably according to the character of the lime used, and the amount and nature of the impurities. The gas houses in Baltimore and Washington, D. C., use mostly Oyster shell lime, and the gas lime from such lime would contain very much less Magnesia than indicated by the average figures. Gas-lime is usually sold at 65 pounds per bushel.

Gypsum or Land Plaster is a combination of lime with Sulphuric Acid (Oil of Vitriol) forming sulphate of lime. It occurs in nature in large deposits forming beds of rock. These are comparatively easily mined, and the rock is ground to a fine powder for commercial purposes. It varies in color from white or light yellow to gray. There are no natural deposits of gypsum in Maryland, Gypsum or sulphate of lime is formed artificially in the manufacture of phosphoric acid and phosphates, by treating the phosphates of lime with sulphuric acid, and a considerable amount of gypsum is necessarily used in agriculture in using dissolved bone and dissolved rock. Average gypsum contains about 32 per cent Calcium Oxide (CaO).

Marl, is a name applied to earthy deposits containing more or less partially decomposed shells. These make the marl more or less friable or easily disintegrated by the weather. Marls are valuable as sources of carbonate of lime, and, when they contain large amounts of lime, they are burned and thus furnish a source of quick-lime. Marls occur widely distributed in Maryland, and vary considerably in character and quality, as will be seen from the discussion and analyses in table VII..

Phosphates of Lime, are used extensively in agriculture, being furnished through the medium of bone, South Carolina, Florida and Tennessee phosphate rock, slag phosphates, and various guanos. These are really used for their phosphoric acid rather than for lime, and so are somewhat outside of the province of this bulletin.

MODES OF ACTION OF LIME.

In considering the question of the use of lime from a theoretical standpoint it would be very natural to conclude that lime is a necessary plant food. Lime is a substance that is just as essential to the plant as Nitrogen, Potash or Phosphoric Acid, and some of it must be present in the soil or no crop can grow. Nevertheless the requirements of the crop in this respect are very small, and but a few pounds of any lime compound per acre would suffice for any crop.

Lime is one of the most abundant substances. It has been estimated that not less than one-sixth of all the rocks on the surface of the earth are lime-stones, and that the element Calcium composes about one-sixteenth of the solid crust of the earth. From this it will be gathered that lime is sufficiently diffused in nature to supply the needs of most plants for this food. Indeed there are few arable soils so poor in lime as not to contain far more than would supply all the demands of crops for years; yet it may happen that in some sandy regions, and in soils that have resulted from the decomposition of certain substances, slates and other rocks poor in lime that there would be a deficiency of lime for serving as nourishment for plants; but in such cases the deficiency of other plant food would be more marked, and in supplying them from the sources ordinarily available the lime would be supplied in abundance for the food requirements of the crops.

The action of lime on soils may be summed up under three heads: 1st., Chemical action: 2nd., Physical action: and 3rd., as supplying a plant food. It is the first and second divisions only that have much importance for the Maryland farmer. Lime is termed an indirect fertilizer in consequence of the little need of it as a plant food, and because of its benefits being derived from its chemical and physical action on the soil. Different kinds of lime have, in the main, much the same kind of action, but they differ in the degree and avidity of the action.

CHEMICAL ACTION OF LIME ON SOILS.

One of the most important chemical changes brought about in a soil through the action of lime is the decomposition of minerals, particularly the disintegration of refractory silicates. Such action as this would generally be produced more easily by caustic or quick-lime than by any other form. Lime materially aids in the formation of double silicates of alumnia, which have an important influence on the fertility of the land. Double silicates of alumina may be described as silicates of alumina in which part of the alumina is replaced by lime, soda, potash or ammonia. Most farmers are aware that ammonia is more valuable than potash, whilst potash is more valuable than soda and soda is more valuable than lime. The double silicates of alumina, when once formed, seem to recognize this, and exercise a similar order of preference. If a double silicate of alumina and lime exist in the soil and should be brought in contact with soda, some of the lime will be given up and soda will replace it, resulting in a silicate of alumina and soda. The presence of the lime will not enable it to replace the soda, as the silicate of alumina prefers the soda to the lime. If, however, potash be added, the soda is given up and potash taken into the combination, because the silicate of alumina prefers the potash. But if ammonia comes within the influence of this compound it will replace either the lime, soda or potash, and silicate of alumina and ammonia would be formed. These double silicates are in such shape as to be lost from the soil by leaching, yet are in a readily available condition for plants. From this it will be seen that it is desirable to promote the formation of double silicates, and caustic lime seems to have a decided action upon clays in starting and bringing about the formation of this most desirable class of bodies.

Lime and Potash.—Lime has not only the effect of aiding in the formation of unions of potash which will be held in the soil, but it also has the ability to liberate potash from combinations which are locked up and unavailable to plants. This is particularly marked when lime is applied to land containing fragments of feldspar. Gypsum is particularly useful in rendering potash available, and the sulphate of lime in dissolved phosphates often have an indirect value in this way.

Lime also favors the production of nitrate of potash in the soil. This is particularly true when lime is used on soils receiving considerable stable manure. The process and changes involved are axactly similar to those which have been employed in many places for the production of nitrate of potash (Nitre) for use in the manufacture of gunpowder, and for which a prize was awarded by the French Government to Mons. Thouvenel in 1776.

Lime and Organic Compounds.—Lime hastens the decomposition of organic matter and inert nitrogen compounds of humus in the soil, and promotes the formation of ammonia and nitrate compounds from the same. It also, as has been seen above, aids in the formation of compounds not easily rested from the soil. Lime promotes nitrifying ferments and makes possible their existence in many cases that would be impossible without its presence.

Lime produces particularly good results if applied after using green manuring, as it acts chemically and unites with some parts of the organic matter and leaves the remainder in a disorganized condition which rapidly decomposes. It is, perhaps, this tendency to destroy organic matter that makes the frequent use of lime pernicious. All evidence teaches us that lime is no substitute for manure but only a reinforcement of it. No doubt much land has been reduced to the verge of sterility by applying lime continually until all the organic matter has been used up. Such procedure is probably responsible for the old proverb, "Lime enriches the father but beggars the son."

Lime and Phosphoric Acid.—If a soil contains much phosphoric acid combined with iron and alumina which is relatively inert, an application of lime will change it into a form available to plants. Lime applied to soils which have received or will receive applications of dissolved phosphates, will not produce any harmful results or cause a loss of the phosphoric acid. It may hasten the reversion of the soluble phosphoric acid, but the phosphoric acid will still be in an available condition. In the average soil this reversion takes place in any case within twenty-four hours after applying the phosphate.

Lime Corrects Acidity.—Most cultivated soils possess a slightly acid reaction. This is generally due to decomposition of the remains of plants in the soil forming organic acids. On wet soils this condition is more noticeable than on dry soils. The sour humus and organic acids are not only unfavorable to the growth of nitrifying ferments and the root tubercles of leguminous plants but also are likely to dissolve iron and other compounds which are poisonous to microdemes and crops. Water-culture experiments have shown that slightly acid solutions are favorable to the growth of plants, and while most soils possess this character to slight degree, yet any excess of soluble acid in the soil would be highly detrimental. While most of our cultivated crops seem to need a slight acidity, it is probable that they have the ability to create this condition to a sufficient degree through the medium of the solutions sent out by their roots. This being the case, it would seem that the aim should be to keep soils in a neutral or slightly alkaline condition so as to favor the growth of root tubercles of the legumens and the desirable soil ferments.

Liming is excellent for correcting any excess of acidity, and is probably the most effective and economical substance for bringing about these other desirable conditions.

PHYSICAL RESULTS OF LIMING SOILS.

The many chemical changes brought about by the action of lime on soils result in producing physical changes which give soils new mechanical characteristics. Lime has the power of changing the physical properties of a clay soil and making it more friable and easily cultivated, and putting it in a condition so that water may pass more freely through it. This will make it less susceptible to extremes of dry or wet weather, and make it a good home for the roots of the plants. The action of lime on sandy soils may be said to be the reverse of that on clay soils: that is it has a cementing action, making such soils stick together and in such a condition that they will hold more water and not dry out so rapidly.

These changes are brought about by what is termed the "flocculation" of the clay and organic particles. It has been found that one (1) part of lime has the power to flocculate and clear 10,000 parts of a turbid liquid, so that it can be readily understood that an application of one ton (25 bushels) of lime would have marked effect on an average soil to the depth of six inches which weighs approximately 900 tons.

OTHER EFFECTS OF LIME.

As has been stated, applications of lime produce a beneficial effect in giving a favorable medium for the growth of nitrifying organisms and of the root tubercles on the leguminous plants (particularly the clover). Lime is also sometimes applied to prevent the "Club-foot" of certain root crops. It is sometimes used to destroy lavae, slugs and worms, but experiments do not bear this out and it is doubtful if it has such an effect. Applications of lime are also supposed to favor the development of certain injurious and undesirable conditions such as the scab disease in potatoes.

EFFECTS OF LIME ON VARIOUS PLANTS.

The experiments conducted by the Rhode Island Experiment Station have resulted in the following classification of plants according to their action with reference to lime:

TABLE I

Giving approximate Effects of Lime on various Plants.

Plants benefitted by Lime	Plants indifferent to lime.	Plants injured by lime.
Spinach,	*Corn.	Watermelon,
Lettuce,	Millet	Serradella,
Beets,	Hungarian Millet,	Blue Lupine,
Okra	Golden "	Sheep Sorrel.
Salsify,	Rye,	
Celery,	Potatoes,	
Onions,	Carrots,	
Parsnips,	R. I. Bent Grass,	
Cauliflower,	Red top Grass,	
Cabbage,		
Cucumbers,		
Egg Plants,		
Cantaloupes,		
Agparagus,		
Kohl-radi,		
Dandelion,		
Sweedish Turnip,		
Pepper,		
Pea,		
Peanuts,		
Martynia,		
Tobacco,		
Sorghum,		
Alfalfa,		
Clover,		
Barley,		
Wheat,		
Oats,		
Timothy,		
Ky. Blue Grass,		
Seed Fruits,		
Stone Fruits.		

*Experiments at this Station have shown applications of lime to corn to give marked increase in yield.

TIME OF THE YEAR TO APPLY LIME.

The fall is generally considered the best time to apply lime, but moderate application may be made at most any time the farmer finds it convenient to perform the work. With the conditions generally prevailing in this State it will usually be found most convenient to haul the lime in the winter and apply it in the spring in order to get it harrowed into the land. Much of the fall grain seed is put on corn ground and this land is not plowed up or in shape to apply the lime conveniently at that season.

It will be noted that most of the experiments reported in this bulletin are with a spring application.

HOW MUCH AND HOW OFTEN TO APPLY THE LIME.

The quantity of lime applied varies considerably in the various sections and at various times. This has probably been due in a large measure to the cost of lime: but more recent observations seem to indicate that it is better to apply small quantities and make the applications at frequent intervals rather than apply very large quantities at one time. The old practice of putting 100 bushels or more per acre is seldom practiced now. The kind of soil to which the application is made makes it necessary to vary the quantity. It is now pretty well recognized that on poor soils and on sandy soils, the quantity applied at one time should be small. The quantity and frequency are points that are under test at this Station, and will be discussed in reporting results hereafter.

METHOD OF APPLYING LIME.

There is probably considerable energy wasted and money lost in the manner in which lime is applied.

In the first place it should be remembered that the tendency of lime is downward in the soil, so it should always be applied at the surface and never plowed under. In the second place it should be remembered that the lime, when in its caustic or quick state, has the most power in producing chemical and physical changes in the soil. For this reason the aim should be to get the lime into the soil in its active state, and have it thoroughly incorporated in the soil before it has had a chance to lose any of its active principles. With this idea in mind, lime should be slacked by means of water, and, as soon as in a powdery state, should be spread over the land and at once harrowed in, to thoroughly incorporate it in the soil. Lime should not be allowed to *"air"* slake, as by so doing it absorbs carbonic acid from the air and is changed back to the carbonate, the form in which it existed before burning and consequently some of that which was paid for in burning is lost. Lime put on small or large piles to slake should be covered with earth to keep it out of contact with the air while slaking, and, as soon as it has come to a powdery condition, it should be spread on the land and harrowed in.

It will generally be found more economical to haul water to apply to the lime and slake it out at once rather than cover with earth. Slacking with water would be a more economical method than to lose part of the value of the lime through air slaking,

Do not apply lime on top of the land with the idea that the rains will dissolve it and carry it into the soil, for, in the first place the rains may not come until after some lapse of time and much of the lime will have returned to the carbonate; and, in the second place, it takes 700 pounds of water to dissolve one pound of lime and that amount of rain could not be depended upon.

Recently lime has been put on the market in a powdered caustic state so that it can be applied to the land with a grain drill or lime-spreader and get it thoroughly incorporated with the soil while it is still in the quick state which, theoretically, should be the best way. This kind of lime also affords an opportunity to apply small quantities and get it more evenly distributed than is possible with a shovel.

HOW TO DETERMINE THE NEED FOR LIME.

There have been numerous methods proposed for determining the need for lime and the probable quantity required; none of them are very reliable and all take more or less skill in their application. The most reliable test is evidenced by the crop, but this takes considerable time. Probably the easiest test is the use of blue litmus paper* for testing the acidity of soils, and if it turns red rapidly it will generally indicate the need for lime. The blue litmus paper test is very simple; it is made by bringing a piece of blue litmus paper in contact with the moistened soil and observing the intensity and rapidity of the redness thus produced.

The general characteristics of the land as to its derivation can not be taken as a sure indication of the lack or supply of lime. It is not infrequent to find that in lime-stone regions and on the so-called lime-stone soils that applications of lime produce most marked results. This is due to the fact that the lime of lime-stone soils has been removed in a great part through prolonged decay and the dissolving action of the carbonated waters. This, not infrequently, leaves such soils so siliceous or ferrugenous as to be quite barren, and of a nature to be benefited by an application of lime. Throughout the areas occupied by the Trenton Limestones in Maryland, nearly every farm has, in years past, had its quarry and lime-kiln for fitting and supplying lime once more to soils that had been so thoroughly leached as to render them lean and poor.

THE OCCURRENCE AND COMPOSITION OF THE SOURCES OF LIME IN MARYLAND.

Maryland is well supplied with lime for agricultural purposes. It is not only abundant, but quite generally and widely distributed.

The source of lime in Maryland may be divided into three general classes: first, lime-stones: second, marls: and third, shells. The lime-stones occur widely distributed throughout the western part of the State, and the marls throughout the tide-water areas of Southern Maryland and the Eastern Shore. The shell, derived mostly from the Oyster, is burned into lime and used more or less in all parts of the State, but most generally in the tide-water sections.

The occurrence of lime in this State is shown by Maps I and II, (accompanying this bulletin) giving the character and location of the deposits of marble and lime-stone in Maryland. These maps were prepared by the Maryland Geological Survey, and procured by us through the courtesy of Dr. Wm. B. Clark, State Geologist, who also furnished us with samples representing these various lime-stone deposits. These samples, 86 in number, are fairly representative in character, of the various geological formations, and their composition will be a much truer index of what could be expected in a given area than the selected samples sent for analysis by

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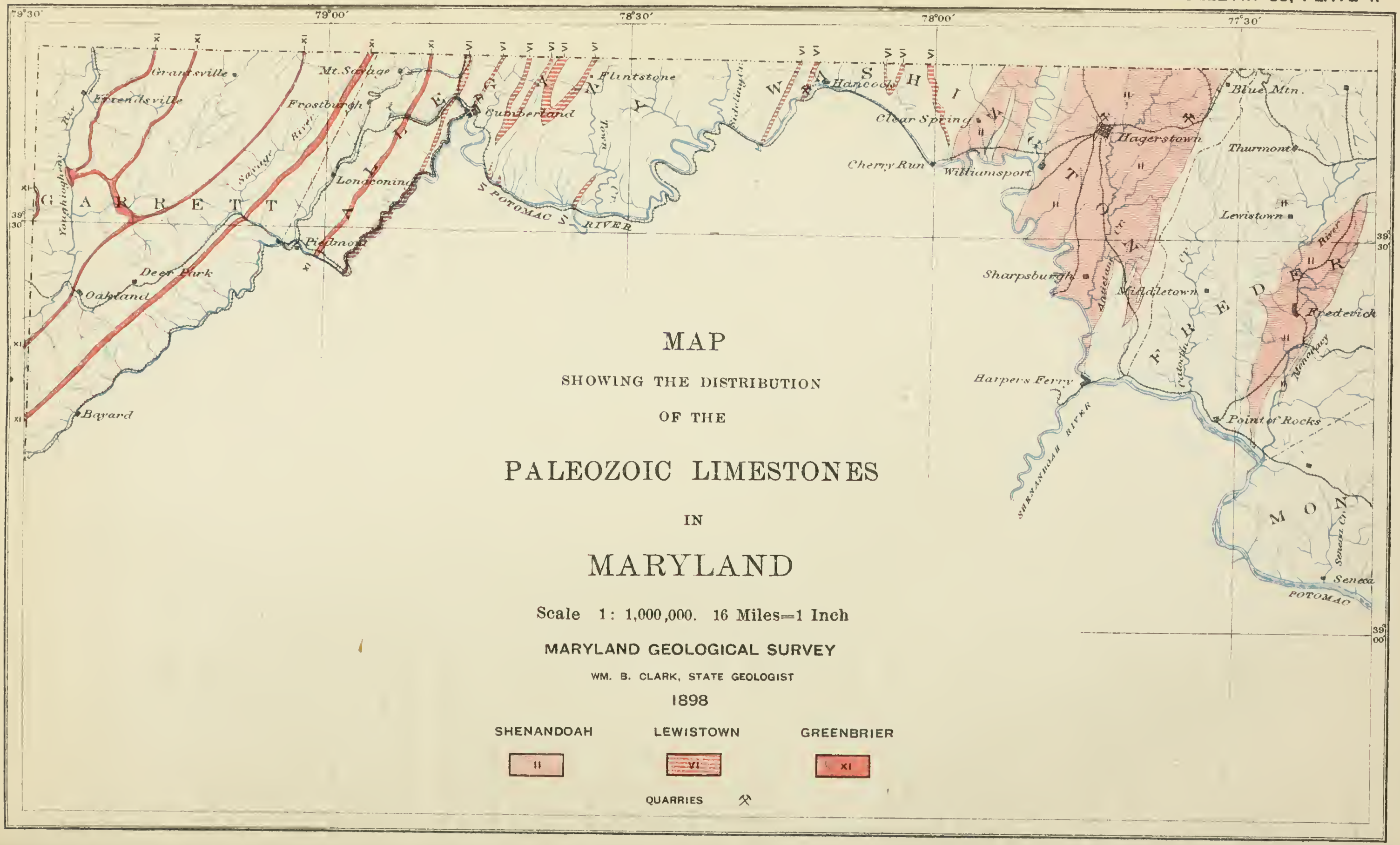
*This can be gotten at any drug store.



MAP

SHOWING THE DISTRIBUTION

OF THE

PALEOZOIC LIMESTONES

IN

MARYLAND

Scale 1: 1,000,000. 16 Miles=1 Inch

MARYLAND GEOLOGICAL SURVEY

WM. B. CLARK, STATE GEOLOGIST

1898

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many of the manufacturers of lime. The details of the analyses of the samples furnishsd by the Geological Survey were performed by Mr. Thomas Malcolm Price, Assistant Chemist of this Experiment Station. The description of these samples, as to Geological classification and locality, is given in the following pages. A more detailed report on these deposits from the Geological standpoint, will be made in the future through the reports of the Survey.

In addition to the report on the analyses of the samples furnished by the Survey, will be given the analyses of those that have come to this Station from time to time during the past twelve years. These samples, in some instances, have been sent by the manufacturers and in others by the users of the lime, hence the Station can only report on the quality of the sample received, and can, in no degree, vouch for the authenticity, of the sample.

In addition to the above will be given a compilation of a few of the analyses of the Maryland limes and lime-stones which have come to our attention. By referring to Maps I and II and comparing the analyses as given in the tables, it will be seen that limestone of good quality for agricultural purposes occur quite widely and generally distributed in Maryland, which, together with the marls and abundance of oyster shells in the bay and tide water sections, puts lime within easy reach of all. The variation in the quality of limestones in this State makes it possible to procure any grade desired, and where special advantages are obtained on some soils through the use of pure lime, magnesium lime or alum lime, they can be taken advantage of, and all at about the same price. A study of the quality of these various deposits makes it evident that where the simple effect of the lime is desired, that it could be obtained by using some of the local sources of lime and thus save much that is now being paid for freight in transporting lime from a relatively distant quarry.

There are few states where the farmers are so fortunate as to have some source of lime at almost every door, and there is no doubt but that it could be used advantageously by many, if applied judiciously.

TABLE II.

Description and Composition of Samples of Limestone furnished by the Maryland Geological Survey.

T. Malcolm Price, Analyst.

(Figures indicate per cents, or pounds in 100 pounds)

Laboratory No.	Survey No.	Geological Classification	Locality.	Insoluble matter, sand silica, etc.	Iron and Aluminium Oxides.	Calcium (lime) Carbonate (CaCO3)	Magnesium Carbonate (MgCO3)	Total
2140	8	Archean	Carroll county	0.43	9.00	89.99	1.02	100.14
2141	4077	Cambrian	Scaggs Quarry 1 mile west of Highlands, Howard county...............	48.39	14.24	35.66	1.96	100.25
2142	4078	"	Wm. Federline's lime kiln; 1½ miles west of Highlands, Howard county	10.13	10.94	75.67	3.70	100.34
2143	4642	Carboniferous.	West of George's Creek; on the north side of Carlos Branch railroad, 3 miles south of Frostburg, Allegany county......................	3.89	12.16	83.57	1.87	99.89
2144	4683	"	West of Lonaconing near the Allegany-Garrett county line; 105 feet above the "Gib vein" Coal Mine, near the "Old Spring" at the new furnace shaft south of Koonts run	4.37	19.62	74.70	2.01	98.69
2145	4685	"	Mouth of stony Run, on the Potomac 2 miles east of Western Port, Allegany county...	3.65	8.44	85.87	1.30	99.26
2146	4	"	Gerrenger & Sugarhart's Quarry, near Friendsville, Garrett county............	13.65	5.44	79.16	1.21	99.46

2147	4698	"	On the west side of Ceorge's Creek & Cumberland Railroad; ½ mile west of Vale summit, in bed of ravine, Allegany county	1.44	6.94	90.40	0.99	99.79
2148	4641	"	From old opening on roadside; 1 mile north of Frostburg, near N. Y. Mine opening, Allegany county	25.01	48.92	7.83	18.70	100.46
2149	3	"	Offut's Quarry, 5 miles south west of Oakland, Garrett county	13.46	12.48	72.92	1.15	99.91
2150	4693	"	Mouth of Stony Run on the Potomac. 2 miles east of Western Port, Allegany county	11.52	3.37	74.48	10.99	100.36
2151	4676	"	In east bank of George's Creek, in town of Barton, Allegany county, only a few inches thick	20.22	25.54	51.10	3.40	100.26
2152	4643	"	Top stratum of lime stone in C. & P. R. R. cut; just south of crossing, near pumping shaft; 3 miles south of Frostburg, Allegany county	10.63	13.18	73.73	1.61	99.15
2153	4715	"	On Potomac Gravity Plain. 1½ miles east of Barton; about 80 feet above bottom of Fairfax formation, Allegany county	9.86	4.90	83.69	1.96	100.41
2154	4709	"	Near top of Fairfax formation; on W. S. Trimble's farm, south-east Mt Savage Station, Allegany county	22.03	51.16	24.80	1.88	99.87
2155	2	"	Lime kiln at Crabtree Station on B. & O. R. R. near Frankville, Garrett Co.	8.57	2.38	88.73	0.86	100.51
2156	4667	"	Mouth of Stony Run, on the Potomac. 2 miles east of Western Port, Allegany county	5.11	3.56	89.08	3.17	99.92

TABLE II—*Continued.*

Laboratory No.	Survey No.	Geological Classification	Locality.	Insoluble matter, sand silica, etc.	Iron and Aluminium Oxides.	Calcium (Lime) Carbonate ($CaCO_3$)	Magnesium Carbonate ($MgCO_3$)	Total
2157	4928	Chert Beds	North Branch, Allegany County.........	53.37	6.24	37.74	2.87	100.22
2158	7	Cockeysville Marble	Cockeysville, Baltimore county............	9.79	5.62	70.64	14.61	100.60
2159	4629	Devonian	30 yards east of church on William's Road; about two miles east of Cumberland; 40 feet above the Romney-Monterey Contact..	30.37	61.62	5.19	2.80	99.98
2160	4639	"	On county road, near spring on fork of road near south end of Warrior Mountain, west of Oldtown, Allegany county......................................	89.80	2.16	7.14	1.07	100.17
2161	4723	"	West side of W. Va. Cent R. R., in cut 20 yards north of Bridge across the Potomac. About 1 mile north of Keyser W. Va., but in Allegany Co..	21.78	4.30	69.08	3.81	98.97
2162	3036	Greenbriar	Barrelville, Washington county.........	5.24	1.98	84.58	7.49	99.29
2163	35	"	South of Negro Mountain, Garrett Co.	20.95	41.10	37.35	0.91	100.36
2164	4103	"	Offut's Quarry; 6 miles north of Oakland, Garrett county.......................	17.00	2.74	62.12	15.75	99.61
2165	8000	"	Findley's Quarry, Piney Run, Garrett county.....................................	4.47	2.70	93.09	6.38	100.28
2166	3057	Lewistown	Cumberland, Allegany county.	3.51	3.30	90.48	2.37	99.60

2167	3055	"	Miller's Quarry, Allegany county........	1.83	2.40	92.96	2.83	100.02
2168	3059	"	Mrs. M. Rowan....................................	3.47	2.64	88.85	4.36	99.32
2169	3058	"	C. F. Thrasher	3.75	2.58	82.41	11.01	99.75
2170	4110	"	Hancock, Washington county.	5.97	12.94	79.42	1.13	99.46
2171	9	"	Pinto, Allegany county........................	20.90	33.14	36.96	8.62	99.62
2172	10	"	" " "	17 91	6.14	73.13	2.48	99.66
2173	11	"	" " "	34.01	5.60	59.03	1.81	100.45
2174	3	"	Clement vein No. 3 Clement Works, Pinto Allegany county........................	26.43	8.18	52.35	12.81	99.79
2175	4	"	Near top layer at Rawlins kiln, Potomac, W. Va..	1.20	3.60	90.69	4.69	100.18
2176	4154	"	Flintstone, Allegany county.	5.57	4.43	84.32	5.93	100.25
2177	4914	"	Cut in B. & O. R R. at Clement Mill Pinto, Allegany county..........................	14.50	4.40	79.41	1.02	99.33
2178	5	"	Potamac Station, Allegany county......	16 33	14.48	62.64	6.17	99.52
2179	2	Monterey	Limey layers near top of Oriskay S. S., Cumberland Allegany county..........	57.49	4.40	26.88	10.79	99.56
2180	7095	Newark	Lime stone *breccia*, Tyson's Quarry, Mt. Pleasant, Frederick county.........	5.75	8.74	76.78	9.15	100.42
2181	4645	Permian	On east side of Cumberland & Pa. R. R.; about 250 yards north of Frostburg, Allegany county	32.41	11.32	53.42	2.33	99.48
2182	4139	Shenando'h	Cavetown, Washington county............	12.00	4.42	83.10	0.93	100.45

TABLE II—*Continued.*

Laboratory No.	Survey No.	Geological Classification.	Locality.	Insoluble matter, sand Silica, etc.	Iron and Aluminium Oxides.	Calcium (Lime) Carbonate ($CaCO_3$)	Magnesium Carbonate ($MgCO_3$)	Total
2183	4151	Shenandoah	Sharpsburg, Washington County.........	0.70	2.84	91.32	5.05	99.91
2184	6	"	Leitersburg, Washington county.........	3.53	3.42	90.01	2.13	99.69
2185	3056	"	Leopold's Quarry...............................	1.51	5.90	89.07	3.25	99.73
2186	4145	"	North edge of Flintstone, Washington county..............................	21.84	12.08	64.33	1.76	100.01
2187	1	"	Keedysville, Washington county.........	0.63	6.30	90.92	2.49	100 34
2189	4150	"	On C. & O. Cent. Canal; 4 miles south of Sharpsburg, Washington county...	2.14	6.70	89.82	1.10	99.76
2188	4127	"	South east of Leitersburg on road near creek..	4.17	8.04	81.73	6.62	99.56
2190	4141	"	Cavetown, Washington county............	20.32	8.60	66.80	3.36	99.08
2191	7006	"	Cramer's Quarry, Mt. Pleasant, Frederick county....................................	11.13	8.00	78.62	2.60	100.05
2192	7115	"	Mountview. Frederick county..	4.99	6.28	84.14	3.97	99.38
2193	7104	"	C J. Keller's Quarry, Buckstown, Frederick county............................	33.36	6.65	57.41	3.02	100.39
2194	7070	"	Union Bridge, Carroll county	0.56	1.50	97.14	0.81	100.01
2195	7071	"	" " "	0.50	2.94	95.44	1.33	100.21

2196	7073	"	" " "	0.43	4.28	94.10	1.64	100.45
2197	7102	"	Fred+rick City, Frederick county.........	1.65	3.26	90.23	5.19	100.33
2198	7021	"	H. Cramer's Quarry, Mt. Pleasant, Frederick county........................	9.06	10.92	78.56	2.07	100.61
2199	7108	"	D. Roddy's Quarry, Thurmont, Fredrrick county....................................	0.52	4.54	92.67	1.80	99.53
2200	7106	"	D. Roddy's Quarry. Thurmont, Frederick county....................................	5.66	0.74	93.05	1.84	101.29
2201	7102	"	Mountview, Frederick, Frederick Co....	4.64	0.14	93.14	1.39	99.31
2202	4199	"	Yost's Quarry. west of Hagerstown, Washington county..............................	4.99	0.44	91.03	3.28	99.74
2203	4180	"	Deitrich Quarry, west of Hagerstown, Washington county............................ .	9.46	4.04	62.10	4.63	99.37
2224	7098	"	Barrett's Quarry, Woodboro, Frederick county	2.33	10.10	81.57	5.60	99.60
2225	3056	"	Leopold's Lime Kiln. This is a duplicate in number and description to No. 2185, but different in appearance	1.93	5.66	83.35	8.50	99.44
2204	4175	Upper Silurian.	A small lime kiln on National road, 4 miles northeast of Cumberland, Allegany county,..................................	0.75	0.16	92.19	7.38	100.38
2205	4618	Top of Silurian	Near the canal at South end of Nicholas mountain; at the Louistown-Monterey contact, Allegany Co.......	10.68	6.98	79.89	2.82	100.35
2206	4125	Silurian	Murray lime kiln: 2½ miles west of Hancock, near the National road......	12.38	3.30	83.59	0.69	99.97

TABLE II—*Continued*.

Laboratory No.	Survey No.	Geological Classification.	Locality.	Insoluble matter, sand silica, etc.	Iron and Aluminium Oxides.	Calcium (Lime) Carbonate ($CaCO_3$)	Magnesium Carbonate ($MgCO_3$)	Total
2207	4153	Silurian	Western Maryland Railroad Quarry; 2½ miles west of Williams Port, Washington county.	4.04	9.80	77.10	8.38	99.22
2208	4128	"	On roadside near Leitersburg, Washington county.	5.42	4.20	89.61	0.07	99.30
2209	4143	"	North suburbs of Funkstown, Washington county	0.62	8.08	85.82	5.88	100.40
2210	4131	"	Roadside near Leitersburg, Washington county	4.08	4.70	82.03	9.71	100.52
2211	4111	"	At side of National Road, in western suburbs of Hancock. Washington county	3.80	4.00	89.53	2.42	99.75
2212	4155	"	Yost's Quarry, about 5 miles west-northwest of Hagerstown Washington county	0.80	4.64	92.19	2.84	100.47
2213	4504	"	From out crop on National road in eastern suburbs of Flintstone, Allegany county	1.88	5.98	89.64	2.42	99.72
2214	4148	"	Near C. & O. Canal; 4 miles south of Sharpsburg, Washington county	1.79	3.46	83.33	11.50	100.08
2215	4177	"	Byer's Quarry. in northern suburbs of Hagerstown, Washington county	3.65	4.44	91.92	0.25	100.08

2216	4179	"	Yost's Quarry, (?) miles west of Hagerstown	2.39	1.47	92.74	2.57	99.17
2217	1	"	Mullen's lime kiln, in northeast part of Cumberland, Allegany county	12.27	12.88	73.46	0.86	99.47
2218	4154	"	So Called "Black Marble". 1½ miles south of Flintstone, Allegany county	5.92	12.98	79.92	0.36	99.18
2219	4500	"	East side of Flintstone Creek ¼ mile north of Flintstone Allegany county.	7.33	9.18	83.60	0.22	100.33
2220	4152	"	Railroad cut, 2 miles north of Keedysville, Washington county	3.21	4.12	91.85	0.74	99.92
2221	4180	"	Dietrick's Quarry; (?) miles west of Hagerstown, Washington county	11.00	8.20	77.51	3.25	99.96
2222	4140	"	Limestone Quarry in Cavetown, Washington county	0.74	6.98	91.01	0.74	99.47
2223	3065	Spencer	Pinto, Allegany County	0.79	9.03	87.03	2.60	99.35

TABLE III.

Description and Composition of Miscellaneous samples of Limestone sent to the Experiment Station for Analysis.

H. J. PATTERSON, Analyst.

(Figures indicate Per cents, or pounds in 100 pounds.)

Laboratory No.	Description of Sample.	Sent by:	Insoluble matter, sand, silica, etc.	Iron and Aluminium Oxides.	Calcium (lime) Carbonate, $CaCO_3$.	Magnesium Carbonate, ($MgCO_3$)	Undetermined	Total.
802	Gray Limestone	M. J. Grove Lime Co , Lime Kiln, Maryland	0.31	0.14	93.49	5.95	......	99.99
803	Blue Limestone	M. J. Grove Lime Co., Lime Kiln, Maryland	3.90	0.36	93.26	2.50	......	100.02
1042	Pulverized Marble	Beaver Dan Marble Co., Cockeysville, Maryland	2.33	1.55	52.33	43.69	0.08[*]	99.98
1542	Limestone	E. H. Brown, Johnsville, Md	7.15	11.90	51.61	27.45	1.89[‡]	100.00
1563	Micaceous Gray Limestone.	Mrs. Hopkins, Highlands, Md.	13.60	5.15	77.82	3.19	0.24[‡]	100.00
1565	Limestone	E. W. Adams, Clarksville. Md	13.00	6.00	50.00	31.00	......	100.00
1567	Limestone	T. T. Hershberger, Frederick, Md.	10.17	5.53	78.12	6.18	......	100.00
1879	Mixture of blue, dark gray and light-gray stone.	J W. LeGore, Woodsboro, Maryland	0.50	0.60	98.39	0.51	......	100.00
1991	Gray Limestone	Aaron Wood, Woodsboro. Md.	5.30	9 80	53.57	31.33	......	100.00
2116	Limestone	J. N. Clery, Frederick, Md.	62.40	7.60	30.00	0.00	......	100.00

2122	Lightest-gray Limestone	J. W. Stimmel, Walkersville, Md.	4.73	1.40	93.51	0.30	0.06	100.00
2123	Gray Limestone	J. W. Stimmel, Walkersville, Md.	4.31	0.90	81.79	13.00	......	100.00
2127	White Limestone	Kerr Bros. Co., Wrightsville, Pa.	0.49	1.80	94.53	3.18	......	100.00
2128	Gray Limestone	Kerr Bros. Co., Wrightsville, Pa.	0.26	3.10	93.32	3.32	......	100.00
2226	Gray Limestone	Joshua C. Miller, Boonsboro. Md.	1.26	10.63	88.07	0.00	0.07	100.00
2227	White Limestone	Joshua C Miller, Boonsboro, Md.	1.95	9.92	83.39	3.19	0.55	100.00
46	Oyster Shells	Sample analyzed by J. R. Laughlin	1.15	1.00	94.75	0.00	2.44†	
47	" "	" " "	1.12	1.31	92.94	0.00	3.79†	

*Water in the marble dust. ‡Potash calculated as K_2O.

†Water—These samples had 0.10 and 0.24 per cent phos-phoric acid, respectively.

TABLE IV.

Composition of Miscellaneous Samples of Maryland Limestone.

(Analyses procured from various sources).

(Figures indicate Per cents, or pounds in 100 pounds.)

Description of Sample	Analyst.	Insoluble matter, sand silica etc.	Iron and Aluminium Oxides.	Calcium (lime) Carbonate, $CaCO_3$	Magnesium Carbonate, ($MgCO_3$)	Undetermined.	Total.
Cockeysville Marble...........................	Schneider..	5.57	0.40	51.90	42.60		100.47
Cockeysville Marble................................	Whitefield..	0.44	trace	54.87	43.84		99.15
Cockeysville Marble..............................	Higgins.....	2.33	0.00	52.33	43.70		98.36
Texas Limestone..................................	Williams....	2.00	0.00	93.00	5.00		100.00
Wash. Co., Limestone, from Dr. 1. Maddox.	Dr. Higgins.	5.80	0.10	90.70	3.18	0.12	
“ “ “ “	“	0.60	0.00	98.53	0.87	0.00	
“ “ “ David Zellers.	“	0.25	......	96.75	2.75	0.25	
“ “ “ B. J. Beyers.	“	2.40	0.60	94.76	2.25	trace	
“ “ “ I. E. Davis.....	“	3.00	0.27	53.94	42.79	trace	
“ “ “ “	“	0.70	0 00	54.93	44.35	trace	
“ “ “ George Heyser..	“	2.00	0.30	95.00	2.60	0.10	
“ “ “ John T. Mason.	“	2.00	0.64	56.50	30.80	0.00	
“ “ “ James Biays......	“	0.60	0.00	98.53	0.87	0.00	

Specimen from head of Pleasant Valley.......	"	6.00	0.20	90.70	3.00	0.00
" " Beaver Creek.........	"	0.20	0.10	97 00	2.50	0.30
" " near Williamsport..........	"	0.50	0.10	98.50	0.80	0.10
" " Carroll County:						
White limestone from Unionville.........	"	0.50	.....	99.50	0.00	......
Dark gray Limestone from Rinehart.............	"	20.20	......	68.30	11.50	......
Dark-gray Limestone with white veins..........	"	0.70	......	98.80	0.50	......

TABLE V.

Description and Composition of Miscellaneous Samples of Burned (Quick) Lime, Sent to the Experiment Station for Analysis.

H. J. PATTERSON, Analyst.

(Figures indicate per cent or Pounds in 100 pounds.)

Laboratory No.	Description of Sample.	Sent by:	Insoluble matter	Iron and Aluminium Oxides.	Lime (CaO)	Magnesia (MgO)	Undetermined*	Total
1043	Woodsboro Lime	W. H. Biggs & Bro., Ricky Ridge, Md.	1.85	3.10	91.10	0.92	3.03	100.00
1044	Cavetown Lime...............	“ “ “ “ ...	2.75	4.83	73.90	17.94	0.58	100.00
1543		Adam Diehl, Jr., Walkerville, Md........	1.35	0.75	83.40	0.72	13.78	100.00
1723	Oyster Shell Lime...........	Purchased in Baltimore City.........	......	......	61.75	......	....	....
1724	Stone Lime.......................	“ “ Silver Spring, Md.........	......	......	95.25	......	....	....
1725	Gas house Lime..............	“ “ Baltimore City..............	......	......	42.50	......	....	....
1732	Wrightsville Lime...........	Edward Boynton, Port Deposit, Md.....	0.15	1.50	67.44	30.91	....	100.00
1790	Grove's Lime....................	P. C. Prough, Freedom, Md................	25.00	2.40	47.10	25.16	0.34	100.00
1791	Black's Lime....................	“ “ “	19.71	7.00	69.80	2.02	1.47	100.00
1848	LeGore's Combination Lime........................	W. O. Thomas, Sudlersville, Md.........	1.63	1.20	96.00	1.08	....	100.00
1949	Frederick City Lime Co's Lime.........................	Frederick City Lime Co., Frederick, Md.	7.70	2.55	84.89	4.86	....	100.00
2019	Aaron Wood's Lime.........	Aaron Wood, Woodsboro, Md............	1.06	2.40	90.00	1.00	4.54	100.00

2130		Benjamin F. Rash, Worton, Md	6.69	9.30	82.00	0.40	1.61	100.00
	Ground Stone Lime.........	Maryland Agri. Experiment Station....	2.60	8.26	82.06	2.94	3.14	100.00
	Glass-house Lime..............	" " " "	6.33	9.56	83.11	0.35	0.65	100.00
	Howard County Lime......	Dr. Tatum, Ashton, Md........................	6.02	13.30	75.40	2.00	3.28	100.00

*Mostly water and carbonic acid gas.

TABLE VI.

Description and Composition of Samples of Quick Lime.

SAMPLED AND ANALYSED BY DR. H. B. MCDONNELL AND F. P. VEITCH.

(Figures indicate per cents, or pounds in 100 pounds.)

Laborto-ry No	Description of Sample.	Sample taken at	In oluble matter, sand, silica etc	Iron and Aluminium Oxides.	Lime (CaO)	Magnesia (MgO)	Water and Carbon-dioxide.	Total.
1	Gas lime, Fresh...........	Canton, Baltimore County, Md............	8.54	2.15	42.44	0.34	44.94	100.00
2	“ “ Weathered 1 year	“ “ “	4.54	1.11	34.81	0.24	57.93	100.00
3	“ “ Fresh	“ “ “	4.41	1.47	37.50	0.29	55.41	100.00
4	“ “ “	Bayard Street, Baltimore, Md....	8.20	1.66	41.60	0.33	46.89	100.00
5	“ “ Weathered 10 years.	“ “ “	8.70	1.65	30 83	0.20	57.70	100.00
6	Oyster Shell lime, slaked fresh.........	“ “ “	8.99	1.84	54.62	0.43	33.27	100.00
7	Oyster shell lime, fresh burned...	H. C. Pearson Packing Co., Baltimore, Md	5.79	2.71	84.58	0.55	5 92	100.49
8	Stone lime from Texas, Md.	Texas Lime Co.. Baltimore, Md	3.32	1.09	86.17	5.82	3.42	100.00
9	“ “ Crucible burned, Select....	Sent by the Standard Lime Co., from Engles, W. Va.......................	0.22	0.44	98.06	0.50	0.67	100.00
10	Stone lime from Frederick.	Washington Grove..............	18.96	3.14	69.18	15.77	2.95	100.00

11	" " " Lime Kiln	Boyds, Maryland	11.65	2.80	62.34	19.69	3.52	100.00
12	" " " Buckeystown	Mt. Airy, Woodbine and Derwood, Md.	12.08	2.95	74.4[illegible]	9.70	1.27	100.45
13	" " " LeGore	Legore	6.27	1.86	87.09	4.39	0.81	100.42
14	" " " Martinsburg, W. Va.*	Rockville and Sykesville, Md	1.72	1.93	93.49	0.73	2.13	100.00
15	Stone lime from Engles, W. Va*	Rockville and Germantown, Md.	12.71	2.20	67.16	16.83	2.13	101.03
16	Stone lime from Buckeystown, Md	College Park, Md	1.69	0.74	77.16	1.19	19.22	100.00

*Composite samples.

NOTE:—The gaslime contained, in addition to the above, small amounts of Sulphur, sulphuric acid, and phosphoric acid; and the Oyster-shell lime, small amounts of phosphoric acid. These have been added in to make the total.

MARLS.

Marls are found in large quantities in many parts of Maryland; and have been used more or less for agricultural purposes for many years. From the small quantity of plant food which marls furnish, and the difficulty and expense of handling and transportation, their use is generally confined to places very near the deposits.

Marls may be considered in three classes, according to their general character and the geological formations in which they occur, being only three of the many formations in this State. These formations are found, as a rule, one above the other, but it is rare that more than one occurs in a single exposure. The upper marl known as shell marl or blue marl, is found in the Neocene or most recent of these formations, at or very near the surface. It consists chiefly of seamud, with sand and clay and partially decayed shells and bones. Its value depends mainly on lime, which it contains in the form of the carbonate. This class of marls usually has a very small percent of phosphoric acid and potash, although sometimes it contains beds of glauconite which gives a higher potash value. The physical character of these calareous marls varies with the class of animal remains from which they are derived, and the state of preservation of the same. To this class belong most of the marls that have been examined at this Station, as this Neocene formation covers a large area in Southern Maryland.

The second class of marls is found in the Eocene formation, which is older than the Neocene and is just below it in the Geological order. It is friable and somewhat chalky, consisting of comminuted shells and corals, and is of a light color. The agricultural value of this variety is given by the potash and the carbonate of lime which it furnishes. The glauconite or green sand may be expected to be found in this class. In parts of New Jersey this is very prominent, but the percentage of potash has been found, as a rule, to be much lower in this State.

The third class, or that which has the lowest Geological position is the Cretaceous marl. This also contains glauconite and is commonly known in New Jersey as "green sand". There are very few exposures of this formation in Maryland and it is difficult to distinguish it from the Eocene. Marls of this class vary considerably in their chemical composition and agricultural value. They owe their fertilizing quality to the presence of phosphoric acid and potash, and sometimes contain a goodly admixture of calcareous matter. The best New Jersey marls, and those that have been used with the most success, have contained from two to three percent of phosphoric acid and from five to seven percent of potash. The few Maryland marls of this class that have been examined here thus far, have not given nearly as high a per cent of these ingredients.

Marls occur in each of these three geological formations in a succession of beds, varying in thickness from a few inches to many feet, and separated by layers of gravel, sand or clay. There may be many of these beds of marl in the same formation, and several beds of the same class are often seen in the same exposure, but the different classes of marl are rarely seen together.

The potash of marls, being in an insoluble form must necessarily act very slowly in the soil. Much of the potash in marls will become slowly available to plants through weathering, but considerable of it could be rendered available by the action of lime, which probably takes place through the formation of the double silicates spoken of on page 95. This change could readily be brought about by burning those marls which contain considerable Calcium (lime) Carbonate, and then slaking the product. This could be performed with profit with some of the marl deposits of the State and give a cheap source of lime, at the same time furnishing some potash and phosphoric acid. Such applications would be highly beneficial to the lands on the farms in the neighborhood of such deposits.

The following table gives the results of the examination of ninety separate samples from various parts of this State. Many of these results are published here for the first time, and some of them were published in the Second, Third and Fourth Annual Reports of this Station. In these reports will be found more detailed description of the various marls than is given here. Many of the samples of marl examined have more than usual interest and value from the fact that they are highly representative of the various classes of deposits in the State, as they were carefully selected, described and classified, by Prof. Milton Whitney, Soil Physicist of the Station, during a geological expedition along the shores of the Chesapeake Bay and the Potomac and Patuxent Rivers in May 1891. Collectively, the samples reported upon in this bulletin are believed to represent in character and composition, all the deposits in Maryland which are so exposed as to be accessible for use.

TABLE VII

Description and Composition of Marls, sent to the Experiment Station for Analysis.

H. J. PATTERSON, Analyst.

(Figures indicate per cents, or pounds in 100 pounds.)

Laboratory No	Description and source of sample.	Insoluble matter.	Lime (CaO)	Phosphoric acid P_2O_5	Potash K_2O
35	Upper layer 7 feet thick. Sent by H. M. Murray, West River	68.50	0.38	0.58	3.22
36	Under No 35. 5 feet thick. “ “ “ “ “	63.77	0.25	0.32	3.02
37	Under No. 36, 40 feet thick. “ “ “ “ “	68.45	0.25	0.34	3.52
38	Deposit near Stream, “ Richard Baldwin, Waterbury	89.02	......	0.08	0.25
42	Sand and shell marl, “ Spear and Critcher, Glymont	46.12	31.92	0.14	0.49
43	“ “ “ “ “ “ “	62.71	17.22	0.05	0.59
49	Lime marl “ Fred. Sasscer, Upper Marlboro	70.76	0.23	0.58	2.37
50	Shell marl “ “ “ “ “	60.51	14.71	0.12	1.89
54	Sand marl, “ L. B. Johnson, Piscataway	61.84	5.37	0.16	1.57
55	“ “ “ “ “ “	44.71	9.00	0.24	2.08
83	Chalky marl, “ Dr. Chas. Lowndes, Easton	18 77	39.90	0.32	0.18
92	Sand and shell marl, “ Geo. Taylor, Glymont	67.70	1.88	0.20	1.78
447	Light brown shell marl. “ J. A. Cunningham, Friendship	77.82	8.56	0.44	0.84
448	“ “ marl, “ P. H. Prout, Friendship	82.67	8.00	0.26	0 28
449	Sand marl “ J. A. Wood, “	92.23	1.06	0 88	0.59
450	“ “ “ “ “ “	92.19	1.00	0.52	0.23
451	Shell marl, “ “ “ “	76.62	11.19	0.89	0.22
452	“ “ “ “ “ “	80.28	9.50	0.14	0.42
453	“ “ rock, “ “ “ “	98.02	......	......	......
454	“ L M. K. Griffith, Dunkirk	83.37	4.25	1.74	0.44
455	Shell marl. “ “ “ “	84.96	0 56	0.12	0.52
456	“ “ “ “	81.86	trace	0.12	2.49
457	“ “ “ “	80.04	“	0.30	2.40
459	Shell marl rock, “ “ “ “	96 96	......	......	......
461	Shell marl “ E. L. F. Hardcastle, Lee Haven	38.39	28.37	0.22	0.43
462	“ “ “ “ “ “ “	26.21	31.94	0.30	0.32

536	Light gray, partly decomposed	“ T. F. Lansdale, Tridelphia		trace	race	0.25
537	“ “ sandy appearance	“ “ “ “		“	“	0.26
585	Shell marl.	“ T. R Brooks, Seat Pleasant	65.48	12.37	0.24	1.41
586	Blue or green sand marl,	‘ “ “ “ “	76.11	4.38	0.30	1.84
587	Shell marl	“ “ “ “ “	69.37	9.88	0.16	1.62
588	Shell marl,	“ “ “ “ “	51.41	22.20	0.16	2.85
589	“ “	“ “ ‘ “ “	64.54	12.37	0.12	1.39
590	Brown sand marl,	“ “ “ “ “	81.22	1.50	0.20	2.08
591	Blue or green sand marl,	“ “ “ “ “	81.84	1.00	0.20	1.71
592	Shell marl,	“ “ “ “ “	53.34	16.87	0.16	2.29
593	Marl Rock,	.. R. S. Mitchell, Glymont	36.09	29.00	0.12	0.23
594	White chalky marl,	“ Dr. Chas. Lowndes, Easton.	13 21	45.88	0.16	0.24
605	Marsh mud	“ Thos. Hill, Baltimore.	87.57	1.38	0.12	0.23
606	“ “	“ “ “ ‘	87.34	1.25	0.14	0.22
610	Light gray marl,	“ Dr. Chas. Tilghman, Tunis Mills	57.58	20.90	0.40	0.29
611	Dark “ “	“ “ “ “ “ “	74.00	13.12	0.28	0.38
612	Muck,	“ “ “ “ “ “	20.88	trace	0.28	0.69
		NEOCENE MARLS.				
1026	Shell marl	From Jones' Wharf	46.76	24.55	0.10	0.24
1025	Under No. 1022	“ Cove Point.	67.24	15.30	0.06	1.88
1027	Shell marl	“ Plum Point	71.43	13.70	0.38	0.72
1021	“ “	“ “ “	73.08	12.45	0.38	0 31
1022	Yellowish-green marl	“ Cove Point.	73.07	12.15	0.06	0.33
		EOCENE MARLS.				
1107	Shell marl	From Bel Alton.	65.51	1.25	0.26	4.76
1106	Shell marl, under No. 1107	“ “ “	67.68	5.10	0.29	4.17
1108		“ “ “	80.94	0.85	0.45	0.73
1167	Green sand marl	“ Upper Marlboro.	75.33	0.45	0.45	2.88
1030	“ “ “	“ Donaldsonville	80.11	0.30	trace	2.71
1019	Shell marl, under No. 1029,	“ Clifton Beach.	52.93	12.70	0.20	2.36
1028	Green-Sand and shell marl,	“ Pope's Creek	78.25	trace	trace	2.35
1105	Shell Marl,	“ Bel Alton	66.00	5.90	0.24	2.34
1079	Green sand Marl,	“ Mathias Point, Va.	78.66	trace	trace	1.81
1023	Shell marl,	“ Clifton Beach.	59 85	11.45	0.16	1.11
1024	Green sand and shell marl	“ Patomac Creek, Va.	84.52	0.85	0.08	1.04
1147	“ “ “ “	“ Seat Pleasant.	50.59	9.10	0.16	0 64
879	green sand marl	“ T. B.	86.46	1.25	0.19	0.59
880	“ “ “	“ “	91.65	0.90	0.41	0.42

TABLE VII—*Continued.*

Laboratory No.	Description and source of sample.	Insoluble matter.	Lime CaO	Phosphoric acid P_2O_5	Potash K_2O
1029	Shell marl " Patomac Creek, Va.	59.09	17.30	trace	0.33
	CRETACEOUS.				
1146	From Seat pleasant.	78.11	2.45	0.18	0.65
	UNCLASSIFIED MARLS AND MISCELLANEOUS.				
1166	Lime marl, 20 feet below surface, Sent by W. G. Worman, Frederick	8.80	50.10	0.08	0.28
799	Marl from near surface " George Earle, Millersville	75.39	12.19	0.48	0.21
798	" " " " " " " "	87.90	1.62	trace	0.38
800	" " " " " " " "	92.90	1.25	"	0.16
1148	Dirt from a well " W. O. Reeder, Laurel Grove	76.69	trace	0.29	1.52
8 8	River mud, " A. T. Parsons, Salisbury	73.05	"	0.19	0.39
1169	Shell and sand marl, " J. L. Rowland, St. Mary's county	82.81	7.37	0.16	0.43
1413	Lime and shell marl, " Alonzo Berry, Williamsport	0.77	54.75	0.08	0.19
1451	Shell and sand marl, " R. J. Manning, Accokeek	52.78	15.87	0.08	1.76
1455	Clam shell marl, partly decomposed, " T. B. Dyer, Oxen Hill	64.28	11.25	0.04	1.81
1456	Sand marl, " " "	89.21	trace	0.28	0.32
1457	Shell marl, " " "	64.08	18.12	0.20	0.40
1458	" " " " "	34.21	33.87	0.24	0.34
1459	Sand marl " " "	77.74	0.05	0.36	0.80
1460	*Bone found in marl deposit, " " "	2.46	......	30.41	0.40
1541	Decomposed stone " W. S. Whiteford, Whiteford	89.42	trace	trace	trace
1726	Shell marl, M. A. E. S.				
1730	" " " J. B. Hallowell	22.83	27.25	trace	trace
1731	" " " " "	29.30	35.25	trace	trace
1738	Shell and sand marl " Randolph Humphreys, Salisbury	63.58	2.15	trace	trace
1741	" F. G. Ankum, Washington, D. C.	59.75	7.25	trace	trace
2075	Shell marl, " Wm. B. Reed, Sr., Centreville	51.32	24.20	1.40	trace
2076	Green Sand Marl, " " " "	70.90	1.20	trace	trace
2117	Shell marl, " Edward Lynch. Westminster	69.42	11.60	......	......
2129	Shell marl, " J. J. Collins, Bishopville	68.92	13.64	......	......

*The bones had the appearance of vertebra.

EXPERIMENTS CONDUCTED WITH THE USE OF LIME ON THE MARYLAND EXPERIMENT STATION FARM.

The First experiment made at the Station, after its establishment, was planned and conducted by Albert I. Hayward, then the Station Agriculturist. This test was made during 1889, 1890 and 1891. The land used was a sandy loam lying on the South-Eastern part of the farm and South of the present tobacco houses. This land was naturally well drained and a good kind soil, but it had been badly neglected in previous years so that it did not give very large yields. The weather conditions, during these years, were not favorable for the crop, and the varieties of seed used proved to be unadapted to this soil and climate, yet the results are comparative.

The crop used in the test during 1889 and 1890 was corn; in 1891 wheat was used.

The following table gives the program of the experiments, and the results with the various crops.

TABLE VIII.

Results with the use of Different forms of Lime on Corn and Wheat.

(Yields per acre in pounds.)

Plot No.	Application	Quantity per A.	1889—Corn.		1890—Corn.		1891—Wheat		Total crop 3 yrs	
			Fodder ℔s	Grain ℔s	Fodder ℔s.	Grain ℔s	Straw ℔s	Grain ℔s	Straw ℔s	Grain ℔s
1	Nothing,	......	2040	1360	1820	2625	103	18	3963	4003
2	Land Plaster.	370	2242	1470	2140	3094	358	102	4740	4666
3	Lime,	2000	2352	2048	2780	3056	2213	642	7345	5742
4	Shell Marl	8000	2016	1312	2420	2874	1156	354	5692	4540

In the above test it will be noted that lime was applied in three forms: viz.—on plot 2, the Sulphate as furnished by land plaster; on plot 3, the oxide or quick lime; and on plot 4 the carbonate, as furnished by the shell marl.

The results as given in table VIII show that the sulphate of lime and the quick lime produced marked effects the first year of application, but that the corbonate showed no effect until the second year. In the sum total of the three years crops, all of the applications proved to be quite beneficial and the quick lime produced the greatest increase in yields.

The next test that was instituted was started in 1890, and was planned and conducted by Albert I. Hayward. The soil used for this test was a stiff clay with gravel subsoil. The piece of land used was situated north of the Station buildings and east of the Pike. This land was a stiff clay, naturally inclined to be wet, and had been steadily cropped in previous years, having received little, if anything, in the way of manure or fertilizer.

The plots were seeded to wheat in the fall of 1889, and cropped the same year without any fertilizer or other application, so as to determine the inequalities of the land. In the spring of 1891 the plots were planted to corn. The plots were one-tenth of an acre each. The following table gives the results obtained:

TABLE IX.

Plot	1890—Wheat			1891—Corn			
	Application	Grain bu.	Straw lbs	Application.	Quantity per A	Grain lbs	Fodder lbs
1	Nothing	13.9	1364	Stone Lime	2000	3570	7050
2	“	13.2	1330	Oyster shell Lime	2000	3320	6500
3	“	12 1	1771	Ground “ “	2000	3540	7180
4	“	9.1	816	Marl	4000	3200	4500
5	“	11.6	1106	Land Plaster	233	3180	4700
6	“	11.4	1255	Nothing	.....	2030	4050
7	Complete Com. Fert.	16.8	1783	Complete Commercial fertilizer.	693	3740	8200

DISCUSSION OF RESULTS.

In this test the same forms of lime were used as in that reported in table VIII, with the addition of the use of Oyster shells both burned and ground. The results obtained are exhibited in table IX.

These results, while covering but a single year, show, however, that all these various applications had the power of materially increasing the yields. The results obtained with the carbonate of lime as furnished by the ground Oyster shells and the marl, are particularly interesting, and it is unfortunate that the effect of these could not have been studied in connection with a variety of crops and covering a series of years.

Owing to changes in the experiments to be conducted, these plots were abandoned and others were substituted, taking up a little different study with limes.

TESTING THE EFFECT OF LIME ON THE USUAL MARYLAND ROTATION.

This experiment was commenced in the spring of 1893, and was planned by Director Robert H. Miller and conducted under his direction until the time of his resignation in 1898. The results, up to that time are summarized in Bulletin No. 56.

“The object of the experiment was to note the effect of lime on a series of crops. Commencing with corn followed by wheat and two crops of hay. This rotation to be repeated with another application of lime previous to planting corn.” Two plots of one-quarter acre each were used in the test. One of these plots received an application of 20 bushels of stone lime per acre and the other received none. The other treatments of these two plots were uniform throughout. The details of the yields of the plots, up to the end of 1897, are given in Bulletin No. 56 a summary of which will be found in the following table, together with the results obtained since that time.

Crimson clover was seeded in the corn at the last working on July 24th, 1897. This made a fair stand and growth. It was turned under on May 28th, 1898, and the land harrowed from time to time during the summer, and seeded to Rocky Mountain wheat on September 29th, 1898. There was 400 pounds of fertilizer applied per acre at time of seeding the wheat. This fertilizer was made up of S. C. Rock—1200 lbs.; Tankage—

400 lbs.; Nitrate of Soda—100 lbs.; and Muriate of Potash—300lbs. This would analyze approximately 9.75 per cent. Phosphoric Acid; 2 per cent Nitrogen and 7.50 per cent Potash.

Timothy was seeded in the fall at the rate of six quarts per acre, and six quarts of clover in the spring. The wheat was harvested in June, 1899. The yields will be found in the following table:—

TABLE X

Yield per Acre of Limed and Unlimed Plots for Six Years.

(Size of Plots used, one-fourth acre).

	Plot 1, Limed		Plot 2 Unlimed		Gain as a result of Liming.			
					Grain.		Hay or Fodder	
Crop and Year.	Grain bu	Hay or Fodder ℔s	Grain bu	Hay or Fodder ℔s	Bushels	Per cent	Pounds	Per cent
Corn—1893	21 4	2200	15.8	1792	5.6	34.7	480	18.1
Wheat—1894	31.3	......	22.8	.....	8.5	37.3	....	..
Hay—1895	......	2662	......	1391	....	......	1271	91.3
Hay—1896		756		360	....	.....	396	110.3
Corn—1897	43.6	2015	26.0	1475	17.6	66.4	540	39.8
Wheat—1899	31.4	1014	22.5	768	8.9	39.6	246	32.0

Rating corn at 40 cents per bushel; fodder at 20 cents per Cwt., hay at 50 cents per Cwt, straw at 25 cents per cwt., and wheat at 70 cents per bushel, and allowing 18 cents per bushel as the cost of the lime, the total value of the grain resulting from the liming of the land would be $32.30; which, after deducting the cost of the lime $7.20, would yield a net profit of $25.10, or $4.18 per year. It is of interest to note that increases in the hay alone more than paid for the lime applied. These figures are sufficient evidence to prove that the application of lime to this land was a beneficial and profitable proceedure.

TESTING THE IMMEDIATE AND LASTING EFFECTS OF DIFFERENT QUANTITIES OF LIME.

This experiment was commenced in the spring of 1896. It was planned by Robert H. Miller, Ex-Director of the Station. The land used in this test is a portion of the sub-division of College Park, and is situated adjoining and East of the Pike and North of College Avenue. This piece of land is a stiff clay, and inclined to be a little wet. It had not been under cultivation for a number of years, and was very poor and unproductive. The only growth on the land, previous to taking it for experiments, was dew-berries with some sedge grass and Golden Rod, but these had accumulated very little vegetable matter, as the custom was to burn it over annually. A more detailed description of the land and of the crops of 1896 and 1897 is given in bulletins Nos. 46 and 56.

When the plots were seeded to wheat they all received an application of fertilizer at the rate of 600 pounds per acre, and were seeded down with timothy and clover. The following table gives the quantities applied to the various plots, and the yields of the crops up to date. The land was plowed in the spring, and, the lime, which was slaked by means of water to a powdery condition, was applied by means of a shovel and immediately harrowed into the land. For the corn crop of 1899 the plots were plowed on April 12th and planted on May 10th. There was no fertilizer used on the corn.

TABLE XI.

Quantity and Cost of Lime Applied per Acre, and Yield per Acre of the various Crops.

Plot No.	Quantity of lime bu.	Cost of lime $	Corn 1896 bu	Wheat 1897 bu	Hay 1898 lbs	Corn—1899	
						Grain bu	Fodder lbs
1	10	1.80	23.9	26.0	2502	35.2	1845
2	20	3.60	25.6	27.7	2367	28.5	2070
3	No lime	.....	17.4	22.5	972	30.5	1845
4	30	5.40	25.8	28.7	2205	34.8	2160
5	40	7.20	27.1	31.9	2322	36.5	2025
6	No lime	.....	15.3	22.7	1053	23.4	1755
7	50	9.00	28.8	31.0	2133	39.8	2115
8	60	10.80	29.8	33.5	2286	42.4	2295

TABLE XII.

Value of Gains Produced per Acre with Different Quantities of Lime.

(In dollars and cents.)

Plot No.	Quantity of lime bu	Value of lime $	Value of gain of corn at 30c's bu. 1896	Value of gain of wheat at 90cts bu. 1897	Value of gain of hay at 50cts cwt. 1898	Value of gain of Corn 1899.		Total value of Gains	Relative profits from gains.
						Grain at 40cts bu.	Fodder at 20cts cwt.		
1	10	1.80	2.28	3.06	7.45	3.28	0.09	16.16	14.36
2	20	3.60	2.79	4.59	6.78	4.60	0.54	19.30	15.70
3	No lime		..	....	...	...			....
4	30	5.40	2.85	5.49	5.97	3.12	0.72	17.97	12.57
5	40	7.20	3.24	8.37	6.55	3.80	0.45	22.41	15.21
6	No lime	....		....	....	......		...	......
7	50	9.00	3.75	7.56	5.60	5.12	0.63	22.66	13.66
8	60	10.80	4.05	8.91	6.37	6.16	0.99	26.48	15.68

The above tables present the results so clearly that it is almost useless to say anything further than to call attention to the fact that small applications of lime have proven to be as efficient at the end of four years as the larger applications, and that the relative profits, up to date, are in favor of applying 20 bushels per acre. It is of interest to note that in the hay crop the ten bushels of lime gave the largest net return.

TESTING THE VALUE OF LIME IN CONNECTION WITH GREEN MANURE.

This Experiment was inaugurated in the spring of 1896, by Ex-Director Robert H. Miller. Two plots were used in the test. They were contiguous to those used in testing the different quantities of lime. The details of the first treatment of these plots were as follows:

The plots were plowed and prepared for seeding on May 12th., when 40 bushels of stone lime was applied to plot 10; plot 9 receiving none. On the 13th., cow peas, at the rate of five pecks to the acre, were drilled in on each plot without any fertilizer. There was quite an apparent difference in the growth of peas on the two plots, both the color and density of the growth, being in favor of the plot receiving the lime. On August 24th the peas in both plots were plowed down. October 2nd they were seeded to wheat, one and one-half bushels to the acre, and six quarts of timothy seed sown. Four-hundred pounds of fertilizer of the same composition as that used on varieties of wheat, was applied. Clover seed was sown on both plots the following spring. The wheat was harvested in 1897. In 1898 hay was taken from these plots, and in the fall they were plowed, and planted to corn in May, 1899. The yields of these crops are given in the following table. The plots were numbered 9 and 10, as they were in the same series as those tabulated on page 126.

The average yield of the no limed plots are repeated here for comparison.

TABLE XIII.

Yields and Value of Gains Resulting from the Use of Cow peas and Lime as Soil Improvers and Renovators.

	No Lime.		Cow Peas and no lime.		Cow Peas and Lime			
Crop & year	Grain bu.	Hay or Fodder lbs.	Grain bu.	Hay or Fodder lbs.	Grain bu	Hay or Fodder lbs.	Value of gain from Cow Peas. $	Value of gain from Lime and Cow Peas $
Wheat, 1897	22 6		32.4	...	34.0		8.82	10 26
Hay, 1898		1012	....	1062	..	1638	0.25	3.13
Corn, 1899	27 0	1800	22.8	1215	27.0	1845	(-2.85	0.09
Total							6.22	13.48
Cost of Peas and Lime							1.25	8.45
Net Gains							4.97	5.03

The same prices were given the respective crops in calculating the value of the gains as were used in table XII page 126

The results obtained in this experiment are in favor of using both cow peas and lime, combined as soil renovators. These results would seem to indicate that the combination had the greater lasting qualities, and also that it would probably be necessary to repeat the use of the peas more frequently.

TESTING THE USE OF DIFFERENT KINDS OF LIME AND SOME OTHER AMENDMENTS.

With a view of studying the effects of different kinds of lime, and different modes of applying the same lime; also of endeavoring to test if the land was responding to lime as a plant food or only needing chemical and physical changes, the following series of experiments were outlined and entered upon in the spring of 1895. The land used in this test is of about the same character as that used in the test described on page 123, and is separated from it by a road 15 or 20 feet wide.

This piece of land was planted in cherry trees in 1889 and kept cultivated, but not cropped in the mean-time. Many of the cherry trees had died out, and the remaining ones had made but little growth, so they were pulled out. For this test the land would permit of plots only ten feet wide and sixty seven feet long with a two foot space between each plot. This gave the plots practically one-sixty-fifth of an acre each. The plots were plowed May 24th 1895, and lime was applied on May 25th. This is the only application of lime which has been made up to this date (May 1900).

The following table gives the application which was made to each plot. The quantities applied in the case of lime, were such as to give each plot the same quantity of Calcium Oxide, which was determined by analysis. Plots are numbered from tobacco barn toward the south.

TABLE XIV.

Lime Experiments.

(Size of plots, 10x67 feet, with 2 feet space.)

Plot No.	Description of Application.		Quantity per acre, lbs
1	Stone lime (Calcium Oxide, CaO) Fresh slaked and applied as a top dressing, not harrowed into the soil.		1400
2	Stone Lime (Calcium Oxide CaO). Freshly slaked and harrowed into the soil immediately		1400
3	Oyster Shell Lime (Calcium Oxide CaO). Freshly slaked and thoroughly worked into the soil immediately		1400
4	Oyster Shell Lime (Calcium Oxide CaO). Worked into the soil before slaking		1400
5	Magnesium Oxide (MgO), worked into the soil with harrow.		1400
6	Barium Oxide (BaO) worked into the soil with harrow.........		1400
7	Nothing		
8	Shell marl (Calcium Carbonate $CaCo$), Worked into the soil with harrow..		13000
9	Finely ground oyster shells (Calcium Carbonate, $CaCO$)......		2600
10	Land Plaster, Gypsum (Calcium Sulphate, $CaSO$)		4125
11	Gas Lime		2925
12	South Carolina Rock, finely ground (Calcium Phosphate $Ca P O$)		2925
13	Soft coal ashes		13000
14	Complete Com. Fertilizer.	Double Superphosphate ...200 Tankage . . ..100 Sulphate of potash......... 80	380

The plots were planted in corn on May 25, 1895, putting three rows to each plot. At the last working of the corn on July 8th the plots were seeded to crimson clover. This clover made a good stand and growth and was turned under on May 14 1896, and again planted to corn on May 26th. The clover was cut September 17th, and the land plowed on October 1st, and thoroughly prepared and seeded to wheat on October 2nd, 1896. There was commercial fertilizer applied at the time of seeding the wheat, at the rate of 600 pounds per acre. This fertilizer was made up as follows:—

Dissolved South Carolina Rock	1000 lbs.
Tankage 10 per cent	500 "
Nitrate of Soda	300 "
Muriate of Potash	200 "
	2000

This fertilizer had approximately the following composition: Phosphoric Acid, 9 per cent; Potash, 5 per cent; Nitrogen, 3½ per cent. The wheat was harvested in June 1897. The plots were seeded with timothy and clover in the wheat, which were allowed to go for hay. Hay was cut June 23rd and hauled in June 27th 1898. On April 14th, 1899, these plots were plowed and thoroughly prepared and planted to corn on May 15th. There was 500 pounds per acre of commercial fertilizer applied broadcast before planting the corn. The fertilizer contained 9 per cent Phosphoric Acid, 7½ per cent Potash, and 2½ per cent Nitrogen.

The yields of the various crops are given in the following table:—

TABLE XV.

Plot	1895—Corn.		1896—Corn.		1897—Wheat		1898	1899—Corn.		Total Yield 5 yrs.	
	Grain lbs.	Fodder lbs.	Grain lbs.	Fodder lbs.	Grain lbs.	Straw lbs.	Hay lbs.	Grain lbs.	Fodder lbs.	Grain lbs.	Fodder & Straw lbs.
1	2989	2308	2604	1950	940	1202	1560	1226	4875	7759	11895
2	3024	2113	2408	1900	1007	1397	2535	751	4550	7190	12545
3	2828	2145	2695	2275	875	1300	2405	975	3900	7373	12025
4	2936	2080	2541	2145	1037	1527	2665	807	5200	7321	13617
5	2716	2210	2408	2047	1202	1786	2210	1644	3250	7970	11504
6	2576	2080	2471	1852	1007	1527	1820	891	4875	6945	12154
7	2490	1950	1946	1885	875	1462	1365	529	3900	5840	10562
8	2940	2011	2989	2112	1335	1917	2925	1361	4550	6825	13515
9	3416	2044	3325	2535	1335	1690	2600	1560	5135	9636	14004
10	2863	2470	1855	2145	909	1527	1235	1058	3575	6685	11952
11	2835	2178	1946	1852	1040	1690	1495	1170	4550	6991	11765
12	2695	2113	2416	2242	1072	1527	2145	628	4225	6811	12252
13	2471	1930	1687	1722	802	1105	1495	752	3775	5712	10047
14	2387	2011	1428	1527	585	1105	845	1530	3900	5930	9388

The results obtained with these plots are, in many ways, very unsatisfactory, as the yields in all cases are not such as would be considered profitable. This, in a measure, is due to not being able to cultivate and prepare such small areas as thoroughly as should be done, and also to the run-down condition of the land and the small amount of organic matter which it contained; but nevertheless the work has been carefully performed and should be comparative. The total yields obtained with the five crops give some peculiar and unexpected results, which cannot be explained by the ordinary and commonly accepted notions as to the action and effects of lime. Some recent investigations in connection with the experiments have shown the land used in these experiments to possess some exceptional and unusal characteristics for this formation, and further study may explain the causes for the results obtained, but these cannot be completed in season for this bulletin so the results will be reported at this time only as a matter of record.

1. It will be noticed that the best yields were obtained with the lime in the form of a carbonate. The finely ground Oyster shells, plot 9, standing first, and the shell marl, plot 8, standing second. This was further substantiated when the stone lime was applied as a top-dressing (Plot 1), and given an opportunity to form carbonate of lime by absorption of carbonic acid from the atmosphere.

2. It will be noticed that pure Magnesium lime, which is commonly claimed to be poisonous to the soil and crop, gave the highest yield.

3. It will be noticed that Barium Oxide, which is not a plant food, produced very nearly as much increase in the yields as the Calcium Oxide, and more increase than the sulphate or phosphate of lime. This would seem to indicate that there was some effect produced on the soil rather than that the plants needed lime as a plant food.

4. It will be noticed that the lime applied so as to slake in the soil (plot 4) produced a slightly better total yield than when first slaked and harrowed in, (plot 3).

5. A comparison of the results of plots 2 and 3, show stone lime and shell lime to be of about the same value on the soil.

6. Lime with fertilizer was more profitable than depending upon fertilizer alone.

7. All the applications of lime increased the yields.

PUBLICATIONS

OF THE

MARYLAND AGRICULTURAL EXPERIMENT STATION.

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" " 64 Jan. 1900, A Study of the Cause of Mottled Butter.
" " 65, March 1900, Insecticides, Fungicides and Spraying Apparatus.

The Culture and Handling of Tobacco.

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COLLEGE PARK, MD.,

June, 1900.

THE
Maryland Agricultural Experiment Station.

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Visitors will be welcomed at all times, and will be given every opportunity to inspect the work of the Station in all of its departments.

The Bulletins and reports of the Station, will be mailed regularly, free of charge to all residents of the State who request it.

ADDRESS:

AGRICULTURAL EXPERIMENT STATION,
College Park, Maryland.

THE MARYLAND
AGRICULTURAL EXPERIMENT STATION.

BULLETIN NO. 67. JUNE 1900.

The Culture and Handling of Tobacco in Maryland.

BY H. J. PATTERSON, DIRECTOR AND CHEMIST.

Tobacco was grown in Maryland by the Indians long before the time of the first white settlers. The early colonists were attracted by it, and soon acquired the habit of its use and spread the same to the mother country. This gave the crop considerable importance for Maryland Colonists, and for nearly two centuries it was closely identified with their social, religious, economic and political development. The crop of 1732 was reputed to be 30,000 hogsheads. at which time it was made a legal-tender at the rate of one penny per pound for all debts, including custom dues and the salaries of State Officers and of Ministers of the Gospel. As late as 1777 the tax rate of Baltimore City and County was fixed at 172 pounds of tobacco per poll.

In 1825, Maryland produced about 15,000 hogsheads of tobacco; in 1846, 41,000 hogsheads, and in 1860, 51,000 hogsheads, which was the largest yield ever produced in the State. During the Civil War the yields decreased until in 1865 it was only 25,000 hogsheads. In 1878 the yield again increased to 46,000 hogsheads, while in 1890 the lowest production of the State ever recorded was 14,000 hogsheads. The yields during the past ten years have fluctuated considerably with the season, as is shown by the figures in table I, but the normal crop might be considered to be about 30,000 hogsheads. This amount could, no doubt, be considerably increased and still meet with ready sale at remunerative prices if the quality were advanced at the same time.

NOTE :—This Bulletin has not been sent to persons on the general mailing list, but only to those interested in tobacco culture. There are about 1500 names of Maryland farmers who grow tobacco, on our special list, to whom copies of this Bulletin have been sent. All others interested may have a copy of this Bulletin and have their names entered on the special Tobacco Mailing List by requesting the same.

TABLE I.

Amount of Tobacco marketed and the Sum paid for Reclamations in Maryland During the Past 10 *Years.*

Year.	Hogsheads.	Reclamation Paid.
1890	14032	$ 329.86
1891	27336	855.27
1892	22437	550.22
1893	25495	609.63
1894	38163	541.61
1895	28085	722.73
1896	29629	1202.43
1897	34875	2101.75
1898	36292	1203.99
1899	31484	717.00

USES OF MARYLAND TOBACCO.

The tobacco grown in Maryland is used chiefly for smoking. It is consumed principally in Europe, (France, Germany and Holland.) France and Germany are the heaviest users of Maryland tobacco, and the price is largely dependent upon the French contract.

Each of these markets demands a particular grade of tobacco, and will not take any other grade or quality, even though of a higher value, at corresponding prices.

While it is impossible, owing to several variations, to get specific types as to color and size of leaf used by the different trades in tobacco, yet every farmer should acquaint himself with the general facts as to quality, texture, size of leaf, &c, demanded by the various markets, and do all in his power to have his tobacco graded and packed accordingly.

METHODS OF SELLING TOBACCO.

Almost the entire yield of Maryland tobacco is sold in Baltimore, where five large ware-houses have been established by the State for the inspection of these goods by State Officers. As soon as a hogshead of tobacco is entered in the ware-house, a sworn and bonded inspector draws six samples of hands from the same. These are taken from different places and at equal distances apart, beginning near the bottom of the hogshead. These six samples or hands are tied together, sealed and labeled with the name of the owner, the number of the hogshead, its net and gross weight and the name of the inspector. The agents of foreign countries buy exclusively by these samples. When the goods are shipped the samples are also forwarded, so that the goods, on reaching their destination, can be compared with the samples by which they were bought. If there should be more than ten per cent. of the tobacco in a hogshead poorer than the sample, the State, through its inspectors, becomes liable for such difference.

There is no charge for storage of tobacco in the State Ware House as long as it belongs to the grower or is in the hands of his agent, but as soon as it is sold there is an outage charge of two dollars per hogshead which is paid by the purchasers. This is paid to the State, and really amounts to inspection charges. The purchaser may leave the tobacco in the State Ware House for six months free of charge, after that time there is a storage charge of ten cents per month per hogshead. The commission charged for selling tobacco is $1.50 per hogshead, which is paid by the grower.

SIZE OF HOGSHEADS.

There had been considerable contention between the growers and handlers of tobacco, as to the weight of tobacco to be put into a hogshead. On this, as well as on the point of even and uniform grading and packing, there should exist no difference of opinion between purchaser and grower, for the real facts show that their interests on these points are identical, and what benefits the one also benefits the other. The Commission man's interest in the-matter is to have the tobacco in such shape as to enable quick sales, and his commission is the same in either case. The reason for not wanting more than a certain quantity in a hogshead is, that the extreme pressure to which it is subjected in the heavy weights, causes the tobacco to come out of the hogshead bruised and lifeless, so that there is great loss in manufacturing. The trade seldom take heavy weights at all, but in a few cases where heavy weights are persisted in, the price is cut down so as to throw the loss of the waste tobacco on the grower. The reason for not wanting less than a certain weight in a hogshead, is, that the freight rates on shipments to Europe are based upon the space occupied, and not upon the weight; hence light weights run up the cost per pound for freight, and the buyer must cut down the price paid proportionately to meet this expense. The trade custom now, in case of light weights, is to mark the actual weight on the margin of the label on the sample, so that the buyer may make his bid accordingly.

The present season is bringing an unusual number of light hogsheads to the market. This is probably due in most instances to the character of the tobacco being produced last season on soils lacking organic matter; as many soils which have been long under cultivation are, in consequence, quite deficient in this respect.

The size of a hogshead varies considerably, but it is generally 52 inches high and 42 inches in diameter, and costs from one to two dollars according to the price of lumber. The limits between which the weight of tobacco placed in a hogshead should run are, from 600 to 850 pounds. The growers should aim to give these weights and please their customers. It pays well to put all products in a shape to please and attract the buyer. Meet the purchaser's desires first, your own second.

GRADING AND PACKING TOBACCO.

There is no part of the work of the Maryland grower of tobacco, so poorly, improperly, and sometimes viciously performed, as the grading and packing. Every man that goes into a barn to strip tobacco should be made to understand that each leaf has a particular value, depending upon its size, color and texture, and that he should grade and make up every hand of tobacco accordingly. The work of separating the different grades into hands that will have uniformity as to size, color and texture, should be as faithfully and attentively performed as is the work of the U. S. Treasury Clerk in handling green-backs of different denominations.

After the grading into uniform hands has been properly executed, the tobacco, when sent to market, should be just as conscientiously packed in the hogshead, so that it will contain but one grade of tobacco.

In case a grower has not enough tobacco of one grade to fill a hogshead, the best way is to pack the different grades in separate layers, and not mix it promiscuously. The hogshead containing a number of grades can then be sold to advantage to the re-packer and so give the grower better returns than by placing it on the general market in a mixed condition.

RESULTS OF BAD GRADING AND FALSE PACKING.

When tobacco comes upon the market with different grades in the same hand, and different kinds of hands, as to size, color or texture, in the same hogshead, it has difficulty in finding a purchaser at any price, and when it is sold the price is such as will permit of throwing out of a grade that does not meet the wants of that particular market for which it was purchased, even though that grade might be considerably better than the bulk. For instance it is not uncommon to find two grades of tobacco mixed in the same hogshead, which if separated, would sell readily for from seven to twelve cents per pound, whereas, in the mixed condition, it is hard to find a buyer for the hogshead at four or five cents per pound.

This loss falls directly upon the grower, and all must concede that such carelessness is being paid for dearly.

There is another kind of grading and packing that is not done through either ignorance or carelessness, and that is the so-called "False packed" hogshead, which is deliberately done with intent to deceive. This is a malicious practice, studied and made a profession of, by many, and indulged in to a considerable extent both by growers and local dealers throughout all parts of the State.

It is this false packing that has done more than any other one factor to demoralize the market for Maryland tobacco. If all the growers of the State had put forth as much effort to study and meet the demands of the tabacco market as some few have put in the study of the art of false packing, the trade for Maryland tobacco would never be dull and the produce never go begging.

As a result of bad grading and false packing there exists in Baltimore to-day a class of dealers who are making good livings and in some instances fortunes, by purchasing mixed hog-heads of tobacco and grading, classifying, repacking and placing them on the market in a condition to meet the demand of a particular market. The profit which this class of dealers makes, represents a portion of the loss which comes to the grower through carelessness in grading and packing.

Every grower should remember that his name goes with every hogshead of tobacco up to the man who manufactures the same into the finished product for the retail trade, and if the tobacco in the hogshead fails in any respect, his name goes back to the buyers to be placed on the black-list which insures him low prices in the future. On the other hand the grower's tobacco that reaches the manufacturer in good shape, evenly and uniformly graded and honestly packed, brings his name back to the buyer to be placed on a list which is almost a guarantee for quick sales at good prices.

The grower, after considering all these facts, ought to make a careful study of the demands of the markets for tobacco, and put forth every effort to meet the demand. It is just as important for every grower of tobacco to aim to please his customers by giving what is wanted in the shape it is wanted, as it is for the merchant. It is only such a course that will establish a reputation which will bring profit to the industry.

Another evil of false packing is the expense incurred for reclamations. The amount paid in this way during the last ten years is exhibited in Table I, page 132. While this is paid by the State, yet in the end it comes off the growers of tobacco.

One cause of so much being paid for reclamations is the result of poor inspections as performed by new and inexperienced people to whom this work is entrusted. The figures in Table I, show this fact very emphatically, and would seem to warrant the inauguration of some method whereby those entrusted to perform this work would be skilled and experienced persons, and in order to be such there should of necessity be more permanency in the tenure of office of those employed in the State Ware House than the present conditions afford.

TOPPING TOBACCO.

Some of the lack of uniformity in tobacco is no doubt due to the methods pursued in topping, and to the lack of care and uniformity in performing this part of the work. If the tobacco is allowed to grow too high and have too many leaves it gives a considerable number of what are termed "crop" leaves, which because of the number, will ripen very unevenly. When these are stripped they are ordinarily put all together in the same hand, with the result that bundles are very mixed in appearance and lack that uniformity of color, texture and size that is so desirable.

Topping is one of the most important operations to be performed in tobacco culture, and it should not be done by careless and inexperienced labor; but by those who have considerable judgment.

Topping should be done so as to have fewer leaves per stalk than is very commonly the case. This will throw the growth to those leaves left on the stalk, and what has been lost in numbers will be made up in the weight of the remaining leaves. Not only will the fewer number of leaves weigh more, but they will ripen up more evenly and give tobacco of uniform quality and appearance when cured and stripped which will sell easier and bring a higher price per pound.

There can be given no hard and fast rules for topping tobacco, as the number of leaves that can be properly matured will vary with the kind of soil and variety of tobacco grown. Again, with the same soil and variety, there will be seasonal variations which will have to be observed, and this can be accomplished only by the exercise of good judgment on the part of the person doing the topping.

There is one point that should be almost universally observed, however, and that is to have all the tobacco of the same crop topped uniformly, so that it will ripen evenly and give uniform grades when cured and stripped.

Topping is the pinching out of seed bud which forms as the terminal bud of the stalk. This should be done as soon as the desired number of leaves per stalk are secured and should not be deferred until the plants are in bloom. In pinching out the bud, care should be exercised not to injure the tender top leaves. A very slight injury will develop into serious blemishes when the leaf has reached its fullest expansion.

The arrangement of the leaves on the stalk makes it possible to do the topping without counting but by simply observing the relative position of the lower and upper leaf.

VARIETIES OF TOBACCO FOR MARYLAND.

In Maryland there are four distinct types of tobacco which are well recognized; viz.: 1, Broad leaf; 2, Broad leaf, thick set; 3, Narrow leaf; 4, Narrow leaf, thick set. There are a considerable number of variations in these types, which might be termed variations due to the character of the land upon which they have been grown, and the methods and standards of selection adopted by the grower.

These types of tobacco are peculiar to this state, and seem to be better adapted to the soil, methods of curing, handling and to the markets which are to be supplied, than any of the imported or socalled improved varieties that have ever been tested. Tobacco experts have in past years, frequently made the statement that all that was necessary to improve Maryland's product was to introduce the proper seed. The proposition has been tested extensively during the past ten years, and in no instance did the new seeds give better results than the old standard sorts, and in most cases the results were disappointing in the extreme, as the quantity and quality were both below the normal.

METHODS OF IMPROVING VARIETIES.

Investigations have shown that some growers of tobacco have improved both the yield and quality of the particular type of tobacco which they are growing by special care in selecting seed. This is a practice that should be more generally indulged in and given special attention by all growers. There is considerable variation in the character of soil used for tobacco, and the only way to get a variety of tobacco that is particularly adapted to a given soil and also other conditions which surround it at the curing season, is by selection. This is not a hard thing to do, and is much more profitable than to expect to get what is desired by the hit or miss method of getting seed from a neighboring farm or from some other locality.

The first thing to decide upon is the type which is best suited, naturally, to your soil and conditions; then by careful observations pick out the plants that are nearest perfection of that type, and save seed from these plants. Save only the seed that is produced on the main or central seed stalk. Cut out all the suckers or lateral seed producing stems, and do not allow them to mature, but throw the strength into the other seed. Then after this seed is ripe, sift out the small, immature and shriveled seed, and throw them away. Planting nothing but the best developed seed it is possible to grow. Following this course rigidly for a few years will result in an almost new variety which will be particularly adapted to a particular farm, and result in improving the yield and quality of the product.

Improving varieties by selection is the only rational method to be pursued by the average farmer, and is precisely the method followed by breeders of stock and by some of the best grain growers, and is especially noted with corn.

CIGAR VARIETIES OF TOBACCO.

There has been a considerable number of experiments performed at this Station with reference to growing tobacco for cigars. These tests have shown that on good land, which is rich in organic matter, by the use of imported Cuban seed it was possible to produce a larger tobacco of fair quality. The most promising tobaccos grown were those intended for filler, and were of the varieties commonly known as Havana, Partidas and Remedios. These as well as Sumatra, produce some fair binders and wrappers, but the proportion which could be used for this purpose was very small. The filler grown so far, when made up, proved to be above the average of the five-cent cigars found on the market. While so much is encouraging as to quality, yet the yield was so much smaller than that given by the Maryland varieties, which, together with the additional care and cost of handling, made the total expenses incurred, more than would be compensated for by the extra price received per pound for the tobacco. Again it would require the market to be specially educated to take any quantity of Maryland cigar leaf, and this would add to the uncertainty of the profits in the product.

THE PLANT BED.

In order to have plants early and get the crop set in season for it to mature in August, so as to be able to avail of good weather for curing, and to avoid the harmful effects of the foggy, wet and muggy weather that is common later, it is necessary to make provision for insuring plenty of plants earlier than was the custom a few years ago.

Plants may be had in good season and in abundance by covering the beds with Plant or Hot-bed cloth. This cloth costs about two cents a yard, and not only protects the plants from sudden and severe changes of the weather, making them develop more rapidly, but also shuts out and gives almost complete protection from the "Flea" beetle, which so commonly kills all the plants. The plants should be uncovered after they have gotten a good start and the danger of the beetle is past, and left uncovered entirely for three or four days before transplanting to the field in order to make them harder.

THE USE OF GREEN MANURE FOR SUPPLYING HUMUS AND IMPROVING THE YIELD AND QUALITY OF TOBACCO,

The quality and yield of Maryland tobacco have decreased considerably year by year in a large measure owing to a deficiency of organic matter in tobacco soils. Most tobacco soils, as well as all soils of the State that have been extensively planted in cultivated crops, have had the organic matter burnt and worked out of them, with the result that the crops now suffer considerably from the extremes of either wet or dry seasons; and also cannot make proper use of the plant foods that are in the soil or are supplied by the use of commercial fertilizers. The cultivation of soils in this condition gives disappointing returns, both as to the quality and quantity of the crop.

The lands on the Experiment Station farm were very deficient in organic matter for tobacco, and, in order to test the means for supplying this, a piece of land was set aside for tobacco in 1894 and has been cropped in tobacco ever since. The course of procedure was to plant the land in tobacco in 1894 in its natural condition but giving a liberal supply of commercial fertilizer. The crop gave a light yield of poor quality which fired badly, giving a large proportion of ground leaves. The crops have all been set early so that the tobacco has been harvested the last of August or the first week in September. As soon as the tobacco was off the land it was worked up with a spring-toothed harrow and seeded to crimson clover covering the seed with a smoothing harrow. The clover came up well every year, but 1899, stood the winters and gave a large amount of green matter to turn under for the succeeding crop. This green manure was supplemented with commercial fertilizer in 1895, 1896, 1897, but in 1898 and 1899 no fertilizer was applied.

As a result of this treatment the crops increased in quantity and quality, and in 1897 the crop was over three times as heavy as in the year 1894. Another noticeable effect of the land being filled with humus was in preventing the crop from firing and losing ground leaves. This was so pronounced with the crop of 1898 as to cause all who saw it to mention the fact. It will be remembered that the crop of the State in 1898 had a larger proportion of ground leaves than ever before known in the trade. In some cases more than one-half of the crop marketed, was ground leaves. The result with the station crop must have been due to the organic matter in tho soil, as the meteorological report showed the lowest rainfall of the State during the critical month to be at the Experiment Station.

By getting the crop of tobacco planted early, from May 10th to June 1st, it will mature so as to leave the land clear for seeding down to crimson clover by the first of September, and certainly not later than the tenth. This will give time for the clover to become sufficiently established to stand the winter, and will give a large amount of matter to turn down the following April or first of May for the succeeding crop of tobacco. This method has the advantage of not only filling the land with organic matter, but also being able to crop the land which is especially adapted to tobacco growing for a number of years in succession.

Should it happen that crimson clover would not do on some land, or that this crop should not suit the convenience of the grower, cow peas could be used for acquiring organic matter.

The deficiency of organic matter in the soil is the cause of tobacco being chaffy and light in weight, and the only way to prevent the light weight hogsheads, which are now so numerous, is to fill the land with humus.

FERTILIZERS FOR TOBACCO.

The first essential in producing a good crop of Maryland tobacco is to fill the land with organic matter. This is necessary not only for its physical effect upon the soil, but also in order that the applications of commercial fertilizers may be properly availed of by the crop. There is no crop that is grown in Maryland that is so susceptible to improvement or to injury by fertilizer as tobacco. Tobacco growers have paid entirely too little attention to the effect of fertilizers on the quality of their product, and it is not uncommon to find that even the manufacturers of fertilizer have but little knowledge upon these points. The deterioration in the quality of tobacco in some sections, and the prevailing low price, is, no doubt in a large measure due to the prevailing ignorance of both the manufacturer and the user as to the effect of different fertilizing elements upon the quality of the product. Again we find some farmers and fertilizer manufacturers often recognize the fact that certain elements produce harmful results upon tobacco, and mix fertilizers accordingly, but there they entirely ignore these facts in preparing fertilizers for other crops which are to be grown on land which has tobacco included in its rotation, presuming, probably, that the harmful results are only temporary and will be dissipated by the other crops grown, but the truth is that the other crops increase rather that lessen the harmful effects of those elements.

The quality of tobacco is something that is not well defined, either from a chemical or physical standpoint. The quality is dependent upon innumeral conditions so that it most frequently becomes impossible to say what special ingredient or class of substances improves or reduces the quality of tobacco. The Agricultural Chemist, in his experiments, is unable to judge for himself, whether he has accomplished an improvement or not, as he can in the case of a starch or sugar producing plant, but he must depend upon the opinion of the expert dealer or user. Even in this, experience has shown that it is difficult to get correct estimates, and, particularly in the case of the users of tobacco, much depends upon the kind of tobacco they have been accustomed to using. There are, however, a few well defined facts which have been clearly determined and upon which methods of fertilization can be based. The bulk of the Maryland tobacco crop is used for smoking, having a special reputation in all the markets of the world because of its good burning qualities. The essential property of a good smoking tobacco, in addition to flavor and aroma, rests in possessing the proper "combustibility", i. e., that it shall continue to burn or remain incandescent for some time after being ignited and shall produce a light gray or white ash, and in cigars that the ash shall be held together.

The combustibility is materially affected by curing, but investigations have shown that combustibility is not wholly dependent upon the extent of fermentation, but that the steadiness and persistency with which a tobacco burns is largely influenced by the composition of the ash which is left after ignition, that is upon the proportion and combination of the mineral constituents of the plant. Bearing these facts in mind it will be evident that an important part to observe in fertilizing tobacco is to have a due regard for quality, particularly the point of combustibility. In applying fertilizers or manures of course it is always desirable to produce an increase in the yield, and with most crops this is the primary and almost the sole object of fertilization, as it is from the increased yield that the profits are derived. With tobacco a very different condition prevails, as it is often easy to produce an increase in the yield, but the product will be of an inferior quality, and consequently the total value of the crop much less than it would have been without fertilization. Again fertilizers will often show little, if any, increase in quantity, but cause a decided improvement in quality, and thus returns by advancing the price received per pound. Experiments that have been conducted at this Station with fertilizers on tobacco have emphasized the above facts. These tests included the use of yard manure, lime, magnesia, phosphoric acid, and different forms of potash, and various combinations of these.

The application of yard manure and proper complete commercial fertilizer produced tobacco of about the same quality and combustibility. Lime and magnesia compounds, in small quantities, seemed to produce but little effect, but in large quantities caused a growth that ripened unevenly and was hard to cure, yet with slightly improved combustibility, but, on the whole, the application of lime immediately before planting tobacco cannot be recommended.

Phosphoric Acid seemed to have but little direct bearing upon the combustibility, but generally produced a marked increase in the yield. The results obtained showed the Potash salts to be the most potent factors in effecting the composition and quality of the tobacco produced. The muriate of potash, Kainit, low-grade sulphate of potash or double-manure-salt, and all potash fertilizer which contains considerable chlorine, caused the tobacco to be of poor quality, and combustibility burning with a flash and having a black charry ash. Hence this class of potash fertilizers, and any substance like common salt which contains much chlorine, should never be applied to tobacco or to land that is to be cultivated in tobacco.

The potash fertilizers, which proved to be beneficial to tobacco, improving both the quality and yield, were those furnishing the potash in the form of the sulphate or the carbonate.

The following materials are well adapted for use in making fertilizers for tobacco:

Dissolved South Carolina Rock, Dissolved Bone, Dried Fish, Bone-tankage, Cotton-seed Meal, Nitrate of Soda, Sulphate of Ammonia, High-grade Sulphate of potash, Carbonate of potash and magnesia, and cotton-seed-hull ashes. As a rule in mixing fertilizers there is not as much Nitrogen and Potash used as would be beneficial and profitable. By the use of crimson clover and cow-peas for adding humus to the soils the amount of nitrogen or ammonia furnished by commercial fertilizer could be either kept low or reduced. Farmers should generally aim to mix their own fertilizers, as by this means they are sure of what goes into the fertilizer, and, as a rule, they get the plant food cheaper than by purchasing it in ready-mixed goods. The mixing of fertilizer can be easily and cheaply done on the barn floor, by the aid of a hoe, shovel and sand screen.

The following figures give the approximate per centage which each one hundred pounds of the various ingredients will represent when they are added to a mixture and the whole made up to a ton or 2,000 pounds :

Each 100 pounds of Dis. S. C. Rock represents 7-10 per cent of phosphoric acid in a ton mixture.

Each 100 pounds of standard dried fish or tankage will represent ½ per cent. of ammonia and 4-10 per cent. of total phosphoric acid in a ton mixture.

Each 100 pounds of Nitrate of soda will represent about one (1) per cent. of ammonia when made up in a ton mixture.

Each 100 pounds of High grade Sulphate of potash will represent about 2½ per cent. of potash when made up into a ton mixture.

For illustration, a fertilizer which has been used with good results on the Station farm for tobacco was made up as follows :—

Dissolved South Carolina Rock,	1300
Tankage (10 per cent),	400
Nitrate of Soda,	100
High-grade Sulphate of Potash,	200
Total,	2000

This contained approximately—

Phosphoric Acid (P_2O_5),	9 to 10	per cent
Potash, (K_2O),	5	"
Ammonia,	3	"

Sulphate of Ammonia and Nitrate of Soda are particularly valuable for use on the plant beds for growing strong and early plants. For this purpose they are applied at the rate of about 100 pounds per acre, sown broad-cast over the land in which case they are mixed with rock, plaster, or dry earth in order to facilitate application. They are also sometimes applied in solution at the time of watering the plants, in which case they are added to the water at the rate of one ounce of material for every four or five gallons of water.

THE RELATION OF ORIGINAL AND NATURAL VEGETATION TO THE ADAPTABILITY OF SOILS FOR TOBACCO CULTURE AND THE MEANS BY WHICH CULTIVATED PLANTS CAUSE TOBACCO SOILS TO DETERIORATE.

It is a well known fact used as a guide in actual practice that the original and natural growths of a soil indicate the adaptability of the soil for tobacco culture. It is also a well recognized fact that certain crops will materially change the adaptability of a soil to the production of good tobacco, that it is often impossible to produce good tobacco after the soil has been cropped with certain plants, and that the soil is always deteriorated by being cultivated for those crops. The question now comes,—what is the relation between those plants and the tobaceo plant, and why should the marked deterioration take place?

We have seen in the discussion of the relation of the elements contained in the ash of the tobacco plant, *that the food given to the plant has a marked influence upon the quality of the product. We have learned that chlorin, when present in the soil in large quantities, is taken up by the tobacco plant to such a degree as to injure the burning quality considerably, probably by modifying the alkalinity of the ash.

Now let us see if the feeding habits of the plants which grow naturally on our lands and of those which we commonly cultivate, do not in some way account for the preference of certain soils for tobacco and also account for the poor quality of tobacco raised after the land has been cropped in some of our other crops. In the study of the ash constituents of the tobacco plant, chlorin and potash seem to have the most marked effect upon quality; consequently, we should naturally expect to find that those elements of the soil and their relation to other crops should throw some light upon the question under consideration.

In order to study this phase of the question, the chlorin and potash content of the principal plants, natural and cultivated, in the tobacco sections have been compiled, and are given in the following table, together with the ratio of chlorin to the potash used by these plants, on the average.

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*Md. Expt. Station Bul. 26, and Article by author in Agricultural Science Vol. 8, p. 329.

TABLE II.

Showing the Relative Amounts of Chlorin and Potash Used by Plants Common in Tobacco Sections.

	Chlorin Cl.	Potash K. O.	Ratio of Chlorin to potash.
Woods:			
Chestnut*	0.9	13.0	1: 14.4
Hickory,*	0.3	18.9	1: 63.0
Oak,	0.2	10.0	1: 50.0
Pine (Black),*	0.7	10.4	1: 14.9
Pine (Old Field),	0.6	2.5	1: 4.2
Pine (Red),	4.0	5.2	1: 1.3
Pine (White)	0.2	1.53	1: 76.5
Pine (Yellow),*	0.8	13.0	1: 16.2
Cultivated Plants:			
Corn (Fodder)	1.4	36.3	1: 25.9
(Grain),	0.9	29.8	1: 33.1
Oats (Straw),	4.4	26.4	1: 6.0
(Grain),	0.9	17.9	1: 19.9
Rye (Straw),	2.2	22.6	1: 10.3
(Grain)	0.5	32.1	1: 64.2
Wheat (Straw),	1.7	13.7	1: 8.0
(Grain),	0.3	31.2	1:104.0
Potatoes (Tuber),	2.8	59.8	1: 21.4
(Vine),	4.6	14.5	1: 3.2
Clover (Red),	3.7	34.5	1: 9.3
Timothy,	5.0	28.8	1: 5.8
Broom Sedge (Andropogon Virginicus)†	6.4	13.9	1: 2.2

*Analysis copied from Bul. No. 2, Ga. Exp. Sta.; other analysis taken from Prof. Emil Wolff's tables.

†Richardson's Analysis of Grasses of United States.

It is well known in Maryland that the pine lands (commonly a species of red pine) are the best lands for tobacco; the chestnut lands rank next, and oak and hickory lands are commonly regarded as poor tobacco soils. In some sections of the State, fields (termed old fields) are allowed to remain idle for some time, with an idea of reclaiming them for tobacco. The most prominent growth on these old fields at first is broom sedge grass (Andropogon virginicus), and if the field is allowed to run long enough, it comes up in pines, known as "old field pines." Now by turning to Table II, we find that there is a very great difference in the ratio of chlorin to potash taken out of the soil by these different plants. We also know that, in a given section, soils do not vary very greatly in their content of chlorin, consequently we see that the differences in amounts of chlorin left in the soil by these natural growths is very material, and enough to account for a difference in the quality of tobacco grown upon the different classes of soils.

An examination of the table also shows that the different cultivated crops take up very different proportions of potash and chlorin, and we can see how these crops would soon create a marked difference in the relative amount of these foods in the soil, and even this difference would be exaggerated when we consider that the amount of available potash would be used up while all the chlorids of the soil would be readily available.

The figures given in the table for the "old field pine" and for the broom sedge; show that these plants are valuable renovators of tobacco lands that produce tobacco of poor quality; and the practice of farmers of turning fields out and allowing them to grow up in sedge and pine has good scientific reasons underlying it.

THE ROOT SYSTEM OF THE TOBACCO PLANT.

Roots are the water and food gatherers of plants. Roots are of two kinds;—the "tap root," the chief use of which is to sustain the plant in an upright position; and the "fibrous roots," which are engaged mainly in absorbing food from the soil. These roots are made up of cells through which the food for the plant is absorbed in solution. Solid matter cannot pass into the plant except it be in solution. The absorption of food is, however, not confined to taking up that which is naturally and readily formed in solution, but the roots produce an acid sap which has a dissolving action on the particles of soil containing plant-foods and thus renders them available.

The roots of tobacco all belong to the fibrous class, and will be seen by an examination of the pictures of the root washings made of plants at different stages of growth, as shown in Figs. 31 to 38.

These plants were grown on the Experiment Station farm in a clay soil which is moderately stiff, and consequently it was impossible to get them washed out without losing some of the roots and particularly the smaller and hairy portions. Hence these pictures represent less than the actual amounts, and, while they are not strictly accurate as to the relative positions of the root system, yet they are as nearly so as it is possible to represent them in a picture.

A careful study of the root system as shown in the engravings will clearly show that they spread steadily outward and downward, and enforce their own lesson regarding the depth of cultivation and of the vast importance of a mulch of loose soil, which will check, as much as possible, the loss of water from the surface of the ground, and hold it to be turned to use in maturing the crop.

CULTIVATION.

The more nearly level and smooth the surface of the ground can be kept, the better. Thorough cultivation does not mean deep cultivation. Tobacco does best on a soil which is deep and loose, but the deepening and loosening of the soil should be done before the tobacco plants are set, and the shallower the cultivation which is given afterward, the more satisfac-

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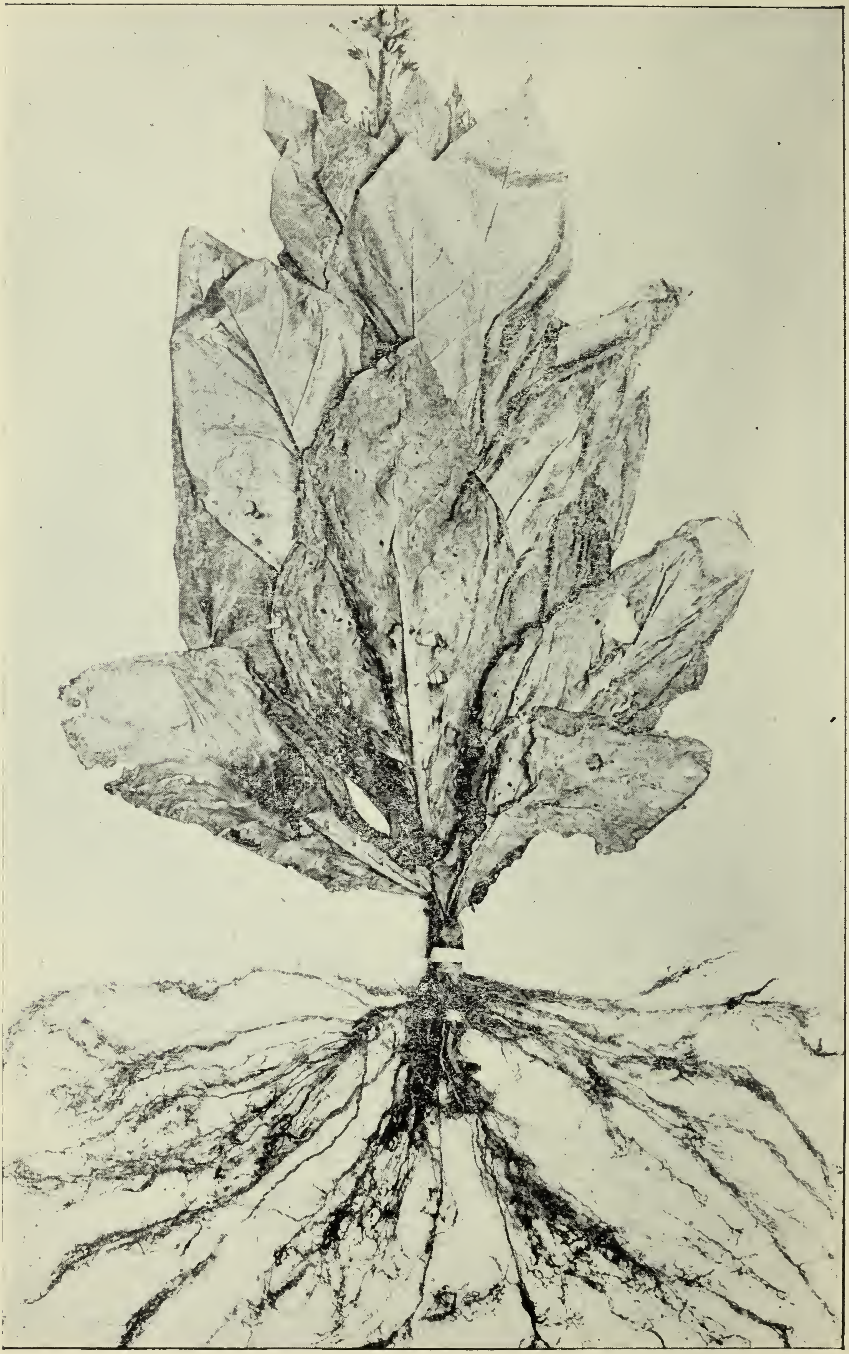

FIG. 31—Root System of Mature Tobacco Plant.

tory will be the results. An examination of the pictures of the root system show that tobacco is in the main a shallow and surface feeder, so that whenever the soil is given a deep cultivation, which disturbs and breaks the roots, the plant is necessarily weakened by having its means for supplying moisture and nourishment decreased.

A constant supply of nourishment is as necessary to a growing plant as to a growing animal, and the cutting off of some of the roots of tobacco, as will be done by cultivating four to six inches deep, gives the plants a check from which they are liable never to recover.

Cultivation should begin immediately after the first rain that follows setting, and should be done as shallow as possible. Very good implements for this purpose are the chizel or harrow-toothed cultivator with pulverizing attachment, or the weeder cultivators. This kind of shallow cultivation should be done frequently and as long as possible, so as to have the land thoroughly mulched with a layer of dry earth.

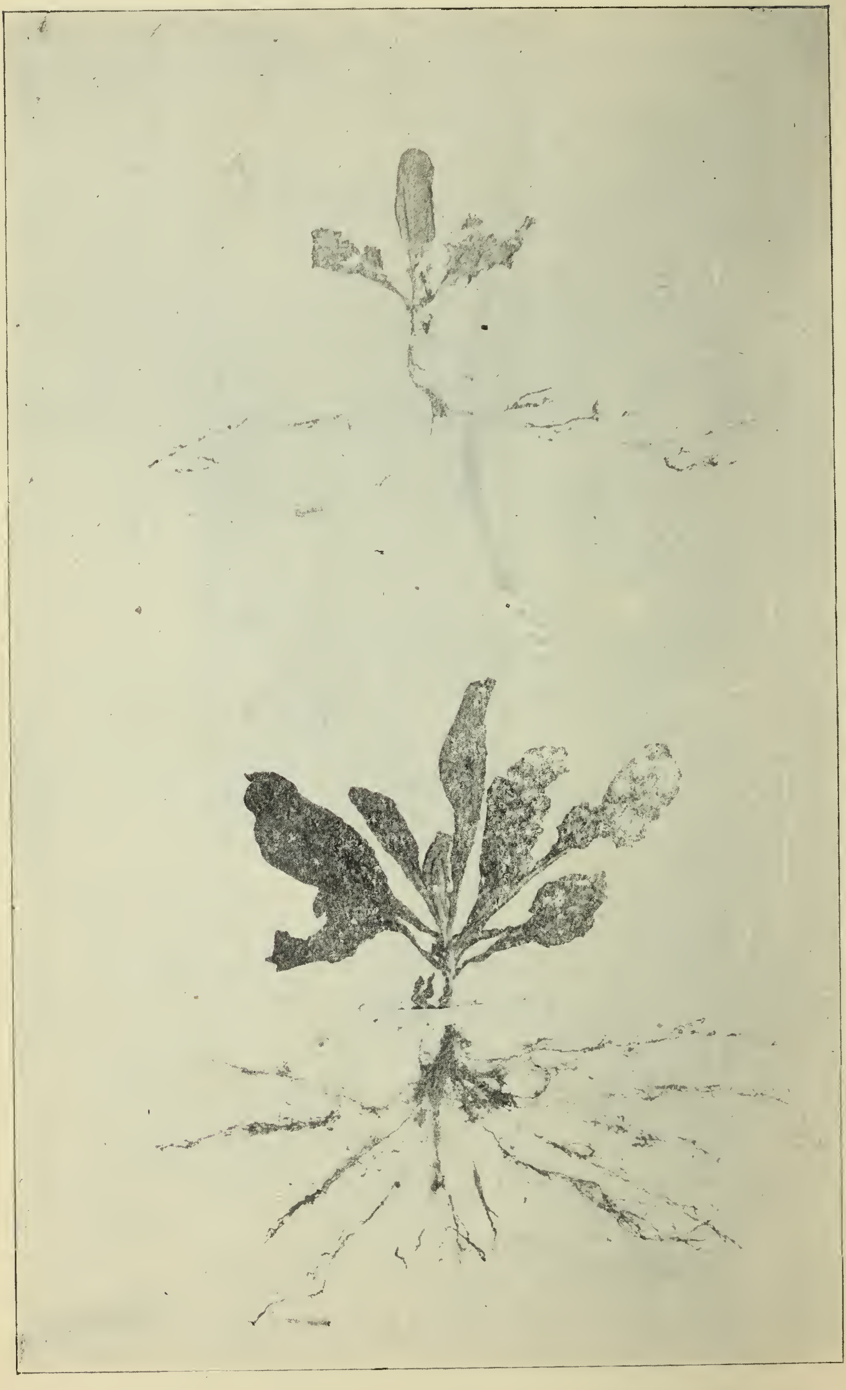

FIG. 32—Root System of Tobacco—Starting to Grow—First and Third Stages.

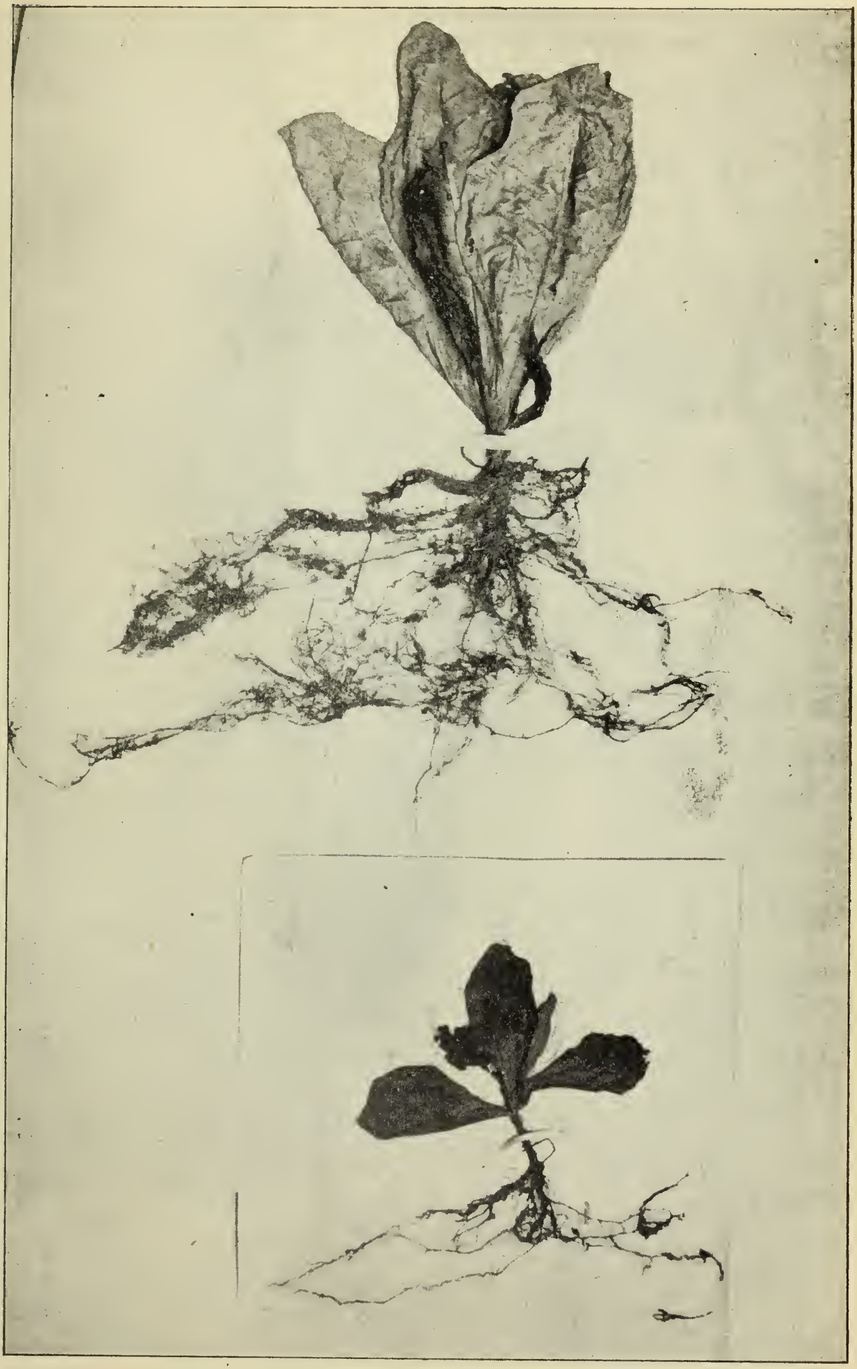

FIG. 33—Root System of Tobacco—Starting to Grow—Second and Fourth Stages of Growth.

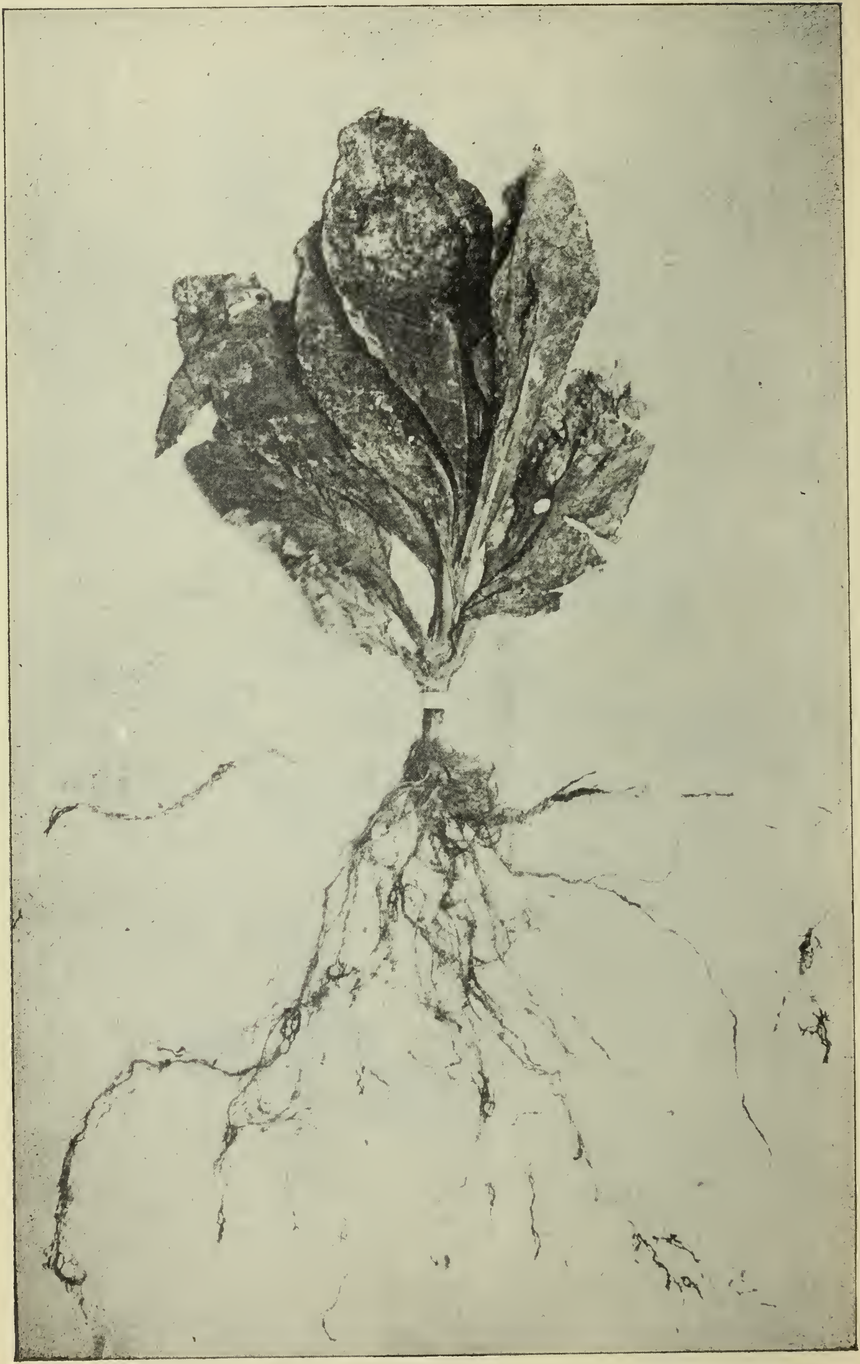

FIG. 34—Root System of Tobacco—Fifth Stage.

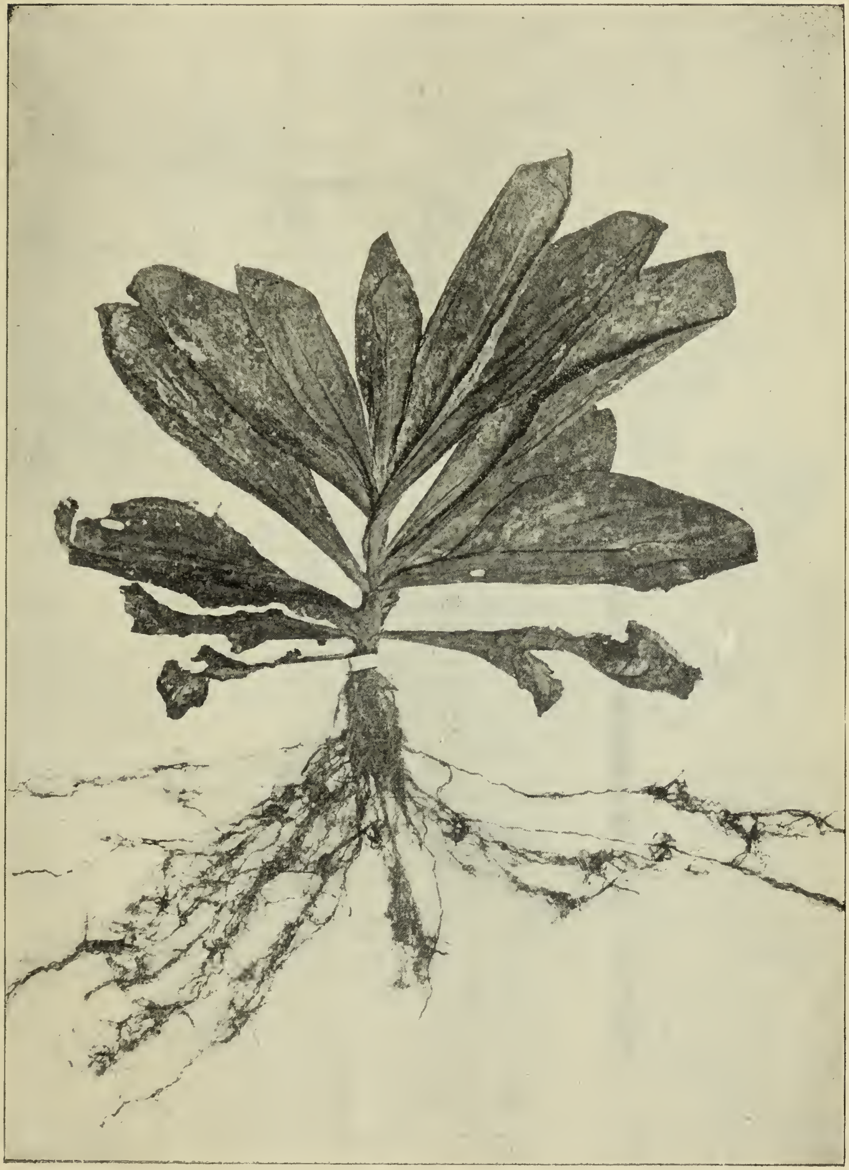

FIG. 35—Root System of Tobacco

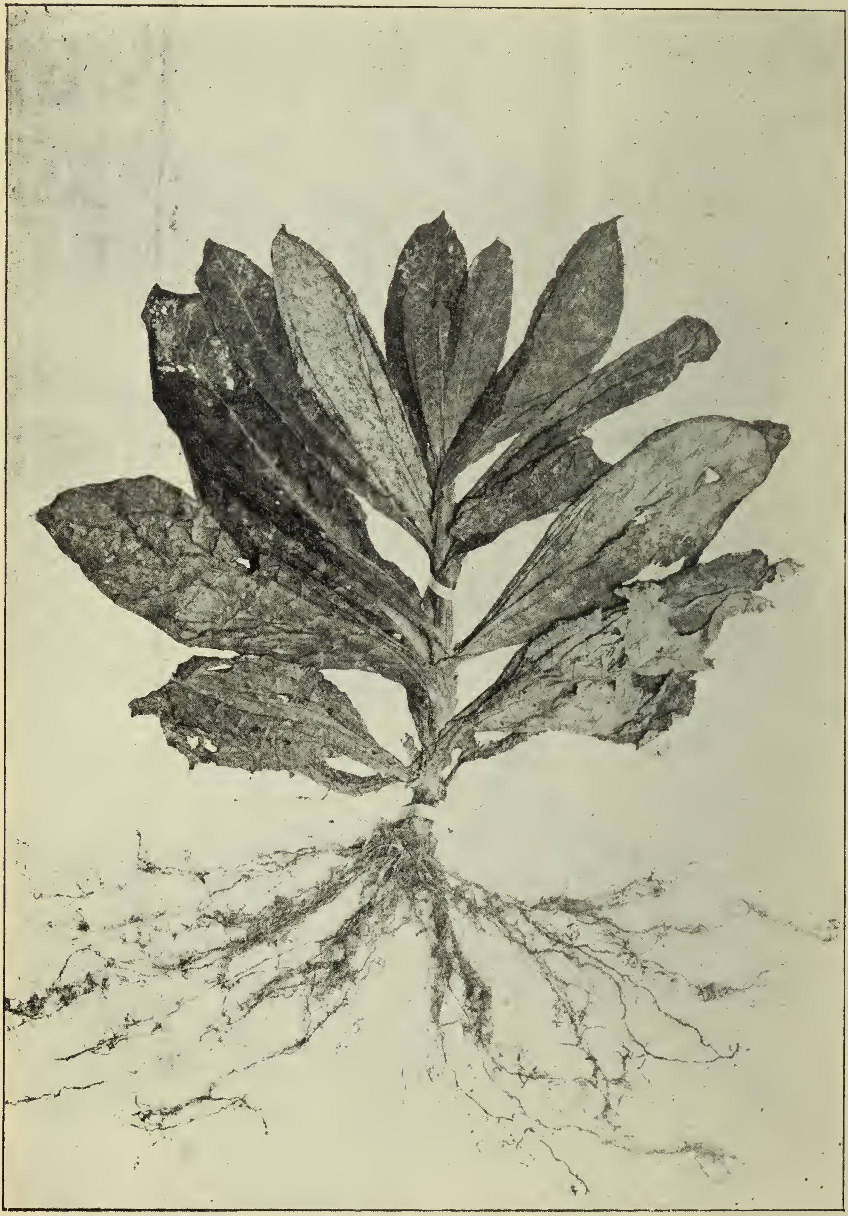

FIG. 36—Root System of Tobacco.

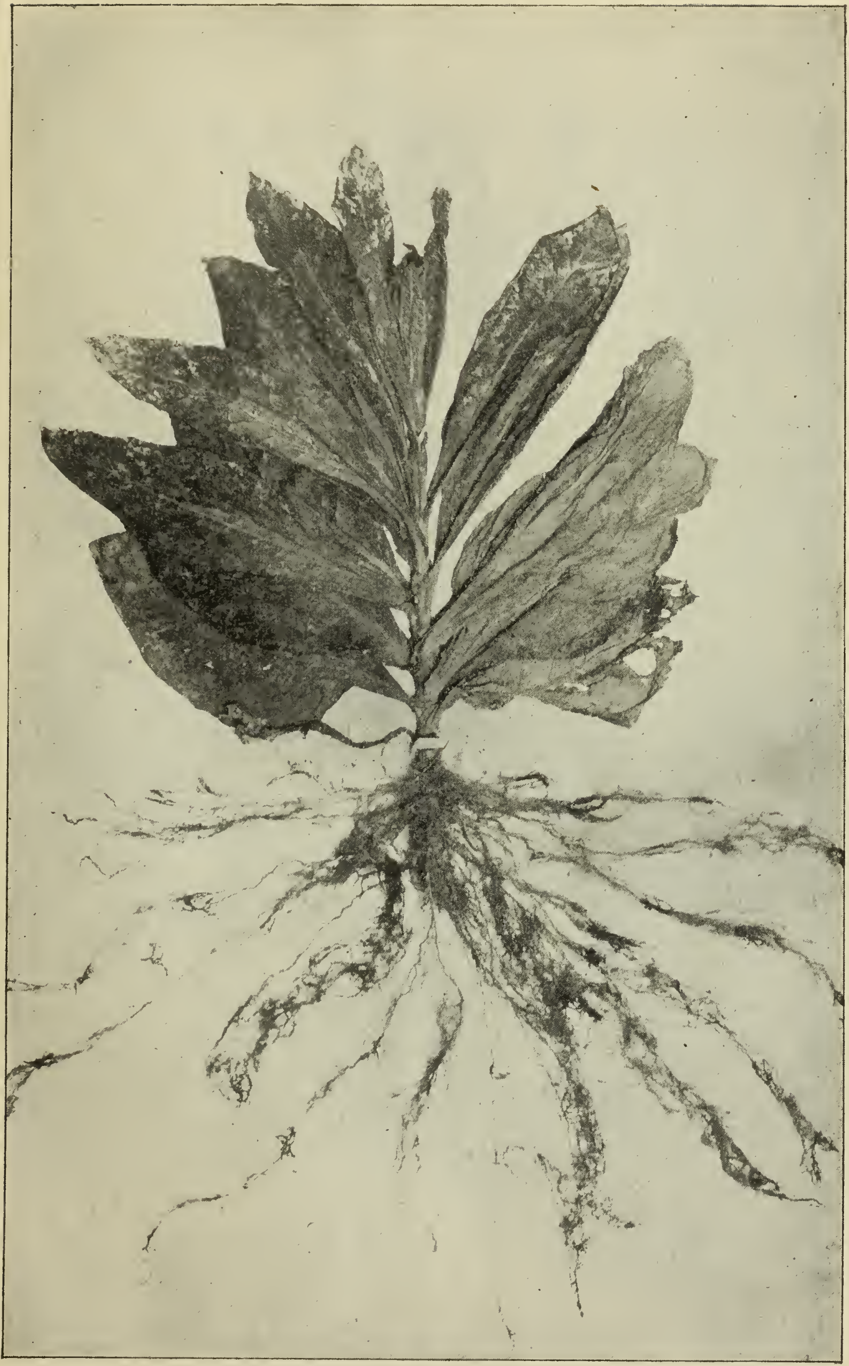

FIG. 37—Root System of Tobacco.

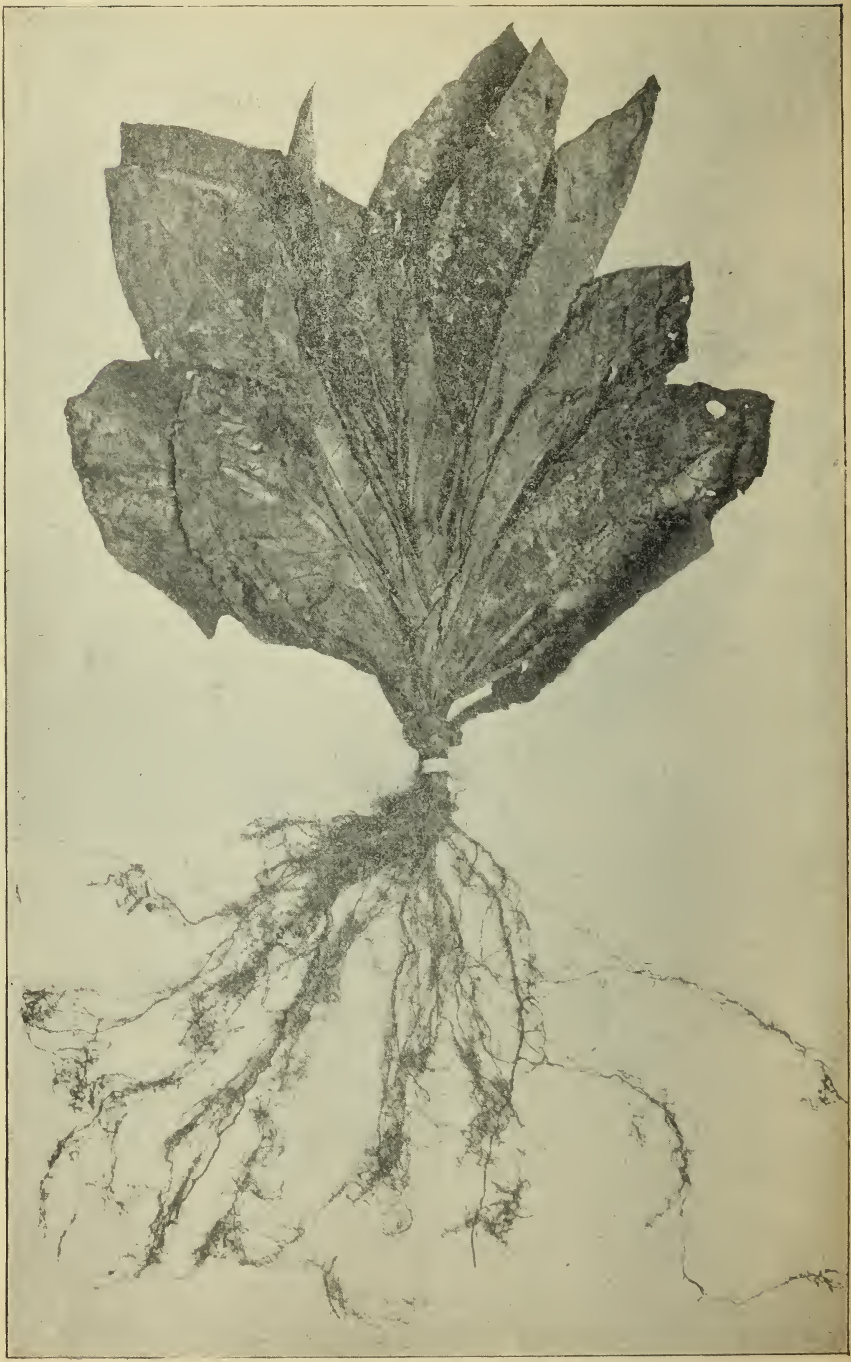

FIG. 38—Root System of Tobacco.

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